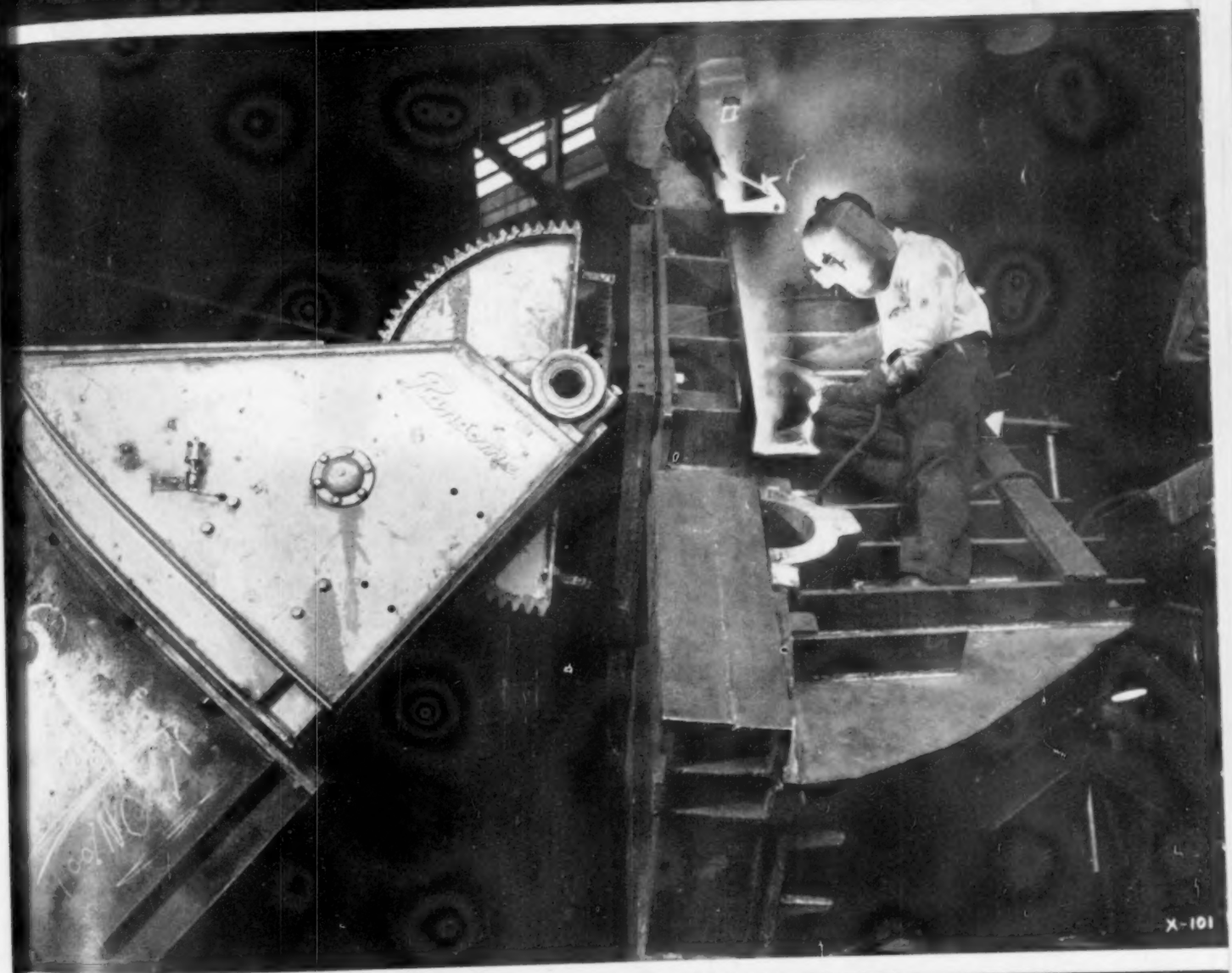
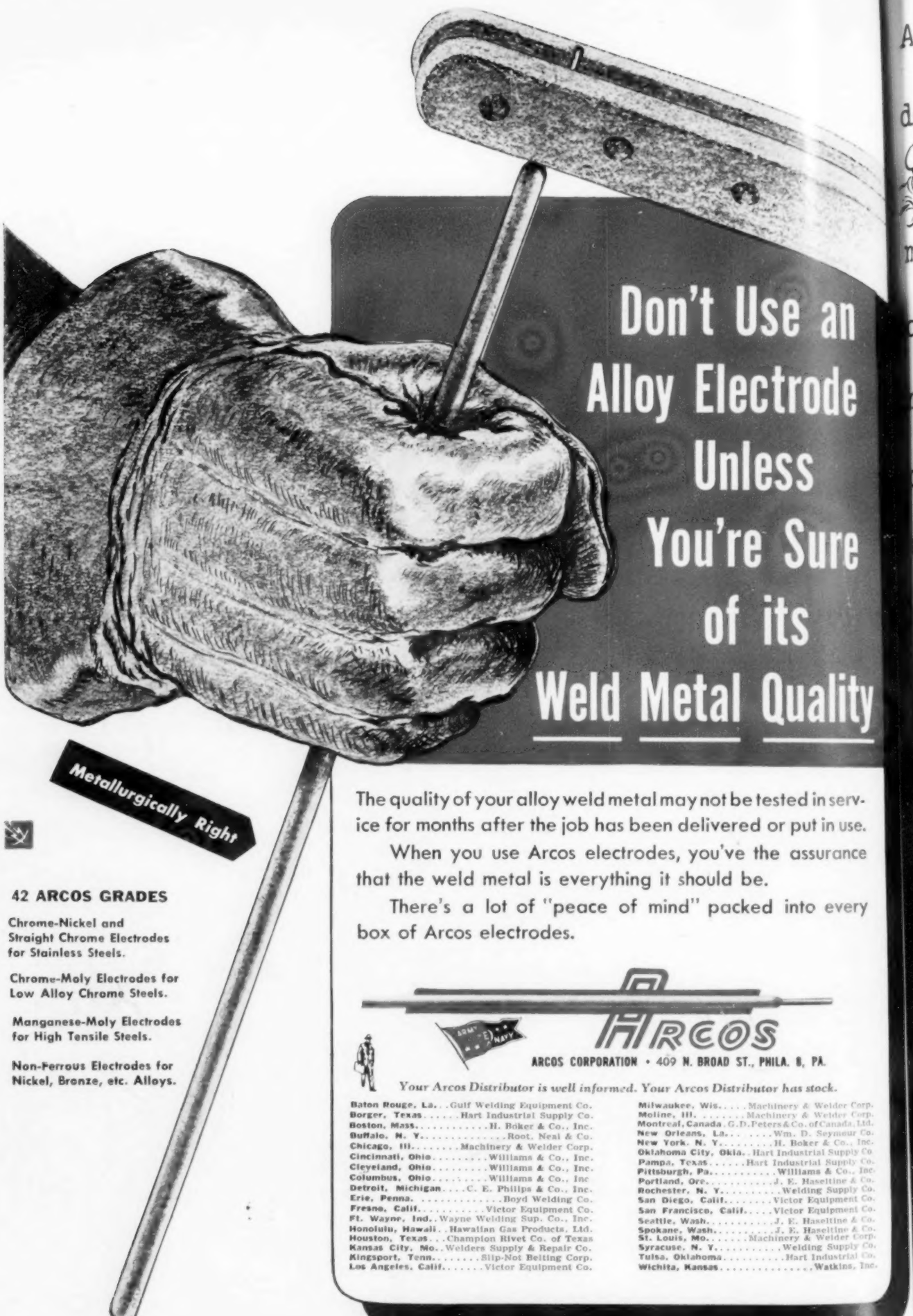
APRIL 1945

WELDING



The Journal of the American Welding Society



Don't Use an Alloy Electrode Unless You're Sure of its Weld Metal Quality

Metallurgically Right

42 ARCOS GRADES

Chrome-Nickel and Straight Chrome Electrodes for Stainless Steels.

Chrome-Moly Electrodes for Low Alloy Chrome Steels.

Manganese-Moly Electrodes for High Tensile Steels.

Non-Ferrous Electrodes for Nickel, Bronze, etc. Alloys.

The quality of your alloy weld metal may not be tested in service for months after the job has been delivered or put in use.

When you use Arcos electrodes, you've the assurance that the weld metal is everything it should be.

There's a lot of "peace of mind" packed into every box of Arcos electrodes.

ARCOS

ARCOS CORPORATION • 409 N. BROAD ST., PHILA. 8, PA.

Your Arcos Distributor is well informed. Your Arcos Distributor has stock.

Baton Rouge, La. . . Gulf Welding Equipment Co.	Milwaukee, Wis. . . . . Machinery & Welder Corp.
Borger, Texas . . . . . Hart Industrial Supply Co.	Moline, Ill. . . . . Machinery & Welder Corp.
Boston, Mass. . . . . H. Boker & Co., Inc.	Montreal, Canada . G. D. Peters & Co. of Canada, Ltd.
Buffalo, N. Y. . . . . Root, Neal & Co.	New Orleans, La. . . . . Wm. D. Seymour Co.
Chicago, Ill. . . . . Machinery & Welder Corp.	New York, N. Y. . . . . H. Boker & Co., Inc.
Cincinnati, Ohio . . . . . Williams & Co., Inc.	Oklahoma City, Okla. . Hart Industrial Supply Co.
Cleveland, Ohio . . . . . Williams & Co., Inc.	Pampa, Texas . . . . . Hart Industrial Supply Co.
Columbus, Ohio . . . . . Williams & Co., Inc	Pittsburgh, Pa. . . . . Williams & Co., Inc.
Detroit, Michigan . . . . C. E. Philips & Co., Inc.	Portland, Ore. . . . . J. E. Haseltine & Co.
Erie, Penna. . . . . Boyd Welding Co.	Rochester, N. Y. . . . . Welding Supply Co.
Fresno, Calif. . . . . Victor Equipment Co.	San Diego, Calif. . . . . Victor Equipment Co.
Ft. Wayne, Ind. . Wayne Welding Sup. Co., Inc.	San Francisco, Calif. . . . Victor Equipment Co.
Honolulu, Hawaii . . Hawaiian Gas Products, Ltd.	Seattle, Wash. . . . . J. E. Haseltine & Co.
Houston, Texas . . . Champion Rivet Co. of Texas	Spokane, Wash. . . . . J. E. Haseltine & Co.
Kansas City, Mo. . Welders Supply & Repair Co.	St. Louis, Mo. . . . . Machinery & Welder Corp.
Kingsport, Tenn. . . . . Slip-Not Belting Corp.	Syracuse, N. Y. . . . . Welding Supply Co.
Los Angeles, Calif. . . . . Victor Equipment Co.	Tulsa, Oklahoma . . . . . Hart Industrial Co.
	Wichita, Kansas . . . . . Watkins, Inc.

An arc welder needs "innards" to stand up under the strain of present day operation

well sir, HOBART has more "innards" than most arc welders. The liberal design of a HOBART you'll find has more copper, more steel, more good insulation, precision bearings and accurate controls, all engineered into a simplified arc welder which makes its performance stand out head and shoulders above the pack.

HOBART gives you 1000 combinations of welding heat, perfectly controllable throughout its range. That's why Hobart assures you of better welds.

Try 'em and you'll prefer them.
HOBART
Electrodes
A Better Rod for Every Purpose
Hobart laboratories make rods for each specific job. It is tested—improved — perfected — order Hobart Electrodes and you'll understand why they're the choice of those who want quality. Write for your price list.

HOBART
"Simplified" ARC WELDERS

"One of the World's Largest Builders of Arc Welders."

NOW AVAILABLE
Volume 2, Practical Design for Arc Welding, with hundreds of ideas for improving your product with arc welding.

● **HOBART BROTHERS CO.**, Box WJ-45, Troy, Ohio
Please send me items checked below, without obligation.
☐ Complete Welding Equipment Catalog.
☐ Sample Pages, "Practical Design for Arc Welding."
Name_____
Position_____ Firm_____
Address_____

Free!
Vest Pocket Welders' Guide
Check for your copies today!
☐ Check How Many

The Journal of the American Welding Society

Published for the Advancement of the Science and Art of Welding

W. SPRARAGEN, Editor

APRIL, 1945

VOLUME 24 NUMBER 4

OFFICERS—1944-1945

President, A. C. WEIGEL
First Vice-President, ISAAC HARTER
Second Vice-President, WENDELL F. HESS
Treasurer, O. B. J. FRASER
Secretary, M. M. KELLY
Technical Secretary, L. M. DALCHER
On Leave of Absence
Acting Technical Secretary, SIMON A. GREENBERG

District Vice-Presidents
District #1 (New York & New England)—F. C. FYKE
District #2 (Mid-Eastern)—H. W. LAWSON
District #3 (Southern)—F. E. McATEE
District #4 (Central)—J. F. MAINE
District #5 (Mid-Western)—W. J. BROOKING
District #6 (Mid-Southern)—M. A. BARRETT
District #7 (Western)—F. A. LONGO

COVER

A Marine Drive Case Being Fabricated on a Welding Positioner. *Courtesy Farrel-Birmingham Company, Inc.*

ISSUED MONTHLY

Copyright 1945, by
The American Welding Society

Subscriptions $5.00 per year in United States and possessions; Foreign Countries $7.00. Single copies, non-members $.75; Special issues October and December $1.00; members 50 cents

Entered as second-class matter January 15, 1932, at the post-office at Easton, Pa., under the act of March 3, 1879.

PUBLICATION OFFICE
20th & Northampton Streets, Easton, Pa.

EDITORIAL AND GENERAL OFFICES
33 West 39th St., New York 18, N. Y.

The Society is not responsible for any statement made or opinion expressed in its publications. Permission is given to reprint any article after its date of publication provided proper credit is given.

CONTENTS

TECHNICAL PAPERS, ITEMS AND REPORTS

Fabrication Cost of Boilers, Tanks and Pressure Vessels as Affected by Plate Widths, by W. G. Theisinger 327
Procedure Control of Automatic Welding Processes, by A. E. Bedell and J. B. Quigley 339
Starting Inside Cuts on Stacks, by N. L. Lindsay 345
Production Planning for Welded Ship Construction with Paper and Plastic 347
Organized Fitting and Welding in Shipbuilding, by Milton Forman 351
Current Welding Literature 357
The LST—Kingpin of Invasion Fleet, by C. M. Taylor 359
Chemical and Metallurgical Control in Welding, by E. C. White 361
Unusual Applications of Gas Cutting to Ordnance Fabrication, by C. M. Underwood 365
Helium-Shielded Arc Welding, by L. V. Barber and H. S. Kennedy 378
Fire Hazard Aboard Ship, by Guy Amodeo 380

SOCIETY AND RELATED ACTIVITIES

Notice to Members 382
1945 A.W.S. Directory 382
Award Program for Textbooks in Modern Design 382
1944 Book of A.S.T.M. Standards 382
Mass Production of Aluminum Bridge Parts 384
INDEX TO ADVERTISERS 384
Maintenance Welding 386
Supporting Companies 386
Welded Gear Blank 386
Electrode Catalog 390
$1000 Prize Contest for Technical Papers on Resistance Welding Subjects 390
Lawson Joins Ingalls 390
Inco Man Made Trent Tube Manager 392
Sustaining Members 392
Sciaky Bulletin 392
1945 Apparatus Catalog 392
Chicago Bridge & Iron Company Reopens Los Angeles Office 394
Oxyacetylene Pipe Line Distributing Systems 394
Handling Long Loads 394
Charlton Promoted 396
Arc-Welded Ice Fighter 396
Bethlehem Steel Promotions 398
Oil Field Engine Improved by Welding Redesign 398
W. R. Persons Becomes Assistant Sales Manager 400
Swaps Frying Pan for Torch 402
Technicolor Film on Arc Welding 402
Holslag's Satirical History of Arc Welding 402
P & H Adds to Welding Staff in Chicago 402
B & W Tube Company Expands Stainless Facilities 402
New Products 404
A.F.A. Votes 1945 Awards 410
Sampson Honored 410
The Guide 1945 410
Radiant Heating Systems 410
X-Ray and Radium Protection 410
Section Activities 412
Employment Service Bulletin 418
List of New Members 420
Members Reclassified 422
Sections—Chairmen, Secretaries and Regular Meeting Dates 429

WELDING RESEARCH SUPPLEMENT

A Study of the Tensile Properties of Heavy, Longitudinally Welded Plate Specimens Simulating Deck and Shell Joints, by Leon C. Bibber 193-s
Gas Evolution in Arc Welding Steels and Its Effects Upon the Welding Process, by Morton C. Smith 226-s
Reviews of Recent Foreign Welding Literature 229-s
The Notched-Bar Impact Test, by John H. Hollomon 230-s
Discussion of The Notched-Bar Impact Test 241-s
Discussion of "Arc Welding of Magnesium Alloys," by N. Teitel and Reply by Author 244-s
Weldability of Manganese-Silicon High Tensile Steels, by George G. Luther, Francis H. Laxar and Clarence E. Jackson 245-s
Discussion of "The Measurement of Energy Absorption in the Tee-Bend Test," by G. F. Comstock 254-s
Notch Impact Tests of Gas Welds, by C. F. Keel 255-s

The Journal of
The American Welding Society
VOLUME 24 • NUMBER 4 • APRIL, 1945

Fabrication Cost of Boilers, Tanks and Pressure Vessels as Affected by Plate Widths*

By W. G. Theisinger†

BOILERS, pressure vessels and similar structures may be built of plates formed as illustrated in Figs. 1 and 2. Figure 1 shows a drum whose length is equal to or greater than its circumference, while Fig. 2 shows a vessel whose circumference is equal to or greater than its length. In either type of assembly, where the shorter dimension does not exceed 195 in. (which is approximately the maximum width of steel plate obtainable), a single plate may be employed. In such case, all the fabricating operations are confined to just one plate, generally of width in excess of 100 in. and, as such, subject to a "width extra" charge in addition to the base price.

To avoid width extras, two plates are sometimes used. This practice requires the handling of two plates instead of one, and more than doubles the number of fabricating operations to produce the same shell. To determine whether one-plate or two-plate construction should be employed, the cost of the additional fabricating operations required for the two plates should be compared with the higher initial cost of the one plate due to its width extra. Width extras are shown in Table 6.

Vessels are also constructed as shown in Figs. 3 and 4, where the circumference of the vessel is large, and its length is in excess of the greatest width of a single steel plate which can be rolled. In vessels of such construction also, the widths of plates used exert an important influence on fabricating costs to a degree which can be determined by a consideration of the fabrication costs and of the width extras involved.

In the one-piece crown and side construction of a locomotive firebox, shown in Fig. 5, the length of the plate is the girth dimension and the width of the plate develops the length of the firebox. In the three-piece structure, Fig. 5, the length of the three plates becomes the length of the firebox. The one-piece type is a simple matter to lay out and roll, whereas the three-piece construction necessitates the handling and forming of three pieces, as well as the welding and the operations incidental thereto.

In addition to the influence of plate width on fabrication costs, there should also be considered its influence on the volume of production and the manpower requirements.

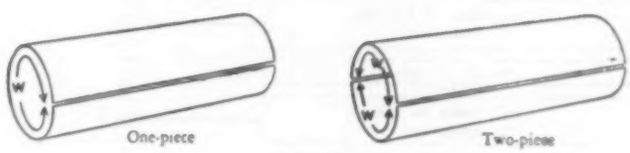


Fig. 1

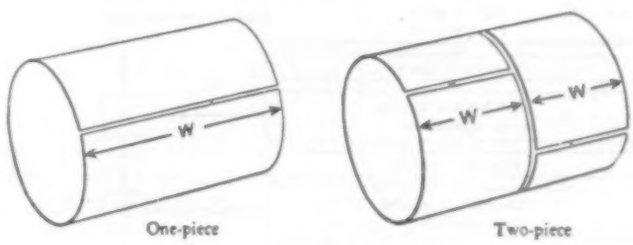


Fig. 2

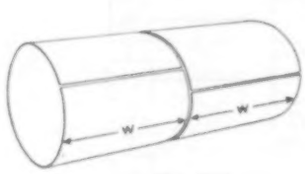


Fig. 3

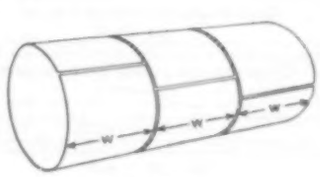


Fig. 4

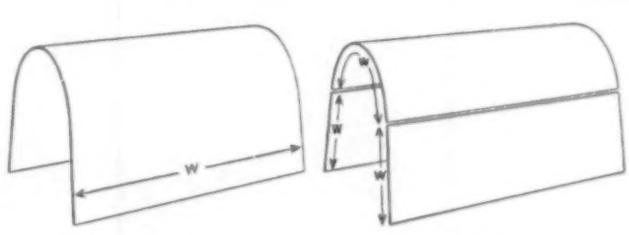


Fig. 5—Locomotive Firebox

One-Plate and Two-Plate Construction

The number of man-hours required to fabricate a vessel can only be reduced by eliminating or reducing fabricating operations in the shop.

* Contributed by the Metals Engineering Division for presentation at the Annual Meeting, New York, N. Y., November 27–December 1, 1944, of the American Society of Mechanical Engineers.

† Assistant to Vice-President, Lukens Steel Company, Coatesville, Pa.

* Heating operations not generally required for plates under 1 in. thick.

Fig. 6

Table 1—Extra Fabricating Costs* for Circumferential Seams, U-68 Construction, 2-In. Thick Plate

Operation	Extra Cost* per Ft. of Seam	Percent Extra Cost
Layout	$ .42	2.21
Trimming	.60	3.14
Machining	.92	4.84
Heating and Crimping	1.50	7.89
Heating and Rolling	2.36	12.41
Shot-blasting	.22	1.16
Fit-Up	.84	4.42
Extra Welding Long Seam	.87	4.58
Clean, Chip and Grind	.29	1.53
Reround	.83	4.37
Resquare and Bevel	1.25	6.58
Fit-up	.83	4.37
Weld Circumferential Seam	5.60	29.46
Chip and Grind	.72	3.78
X-ray	1.76	9.26
	$19.01	100.00

*These cost figures include 133 percent shop burden, but not sales or administrative expense or profit. Shop burdens have been found to vary from 100 to 200 percent.

Figure 6 is a flow sheet showing the comparison in the number of fabrication operations for the one-piece and two-piece shells shown in Fig. 2. In the two-piece shell the narrow plates are joined together by means of a circumferential seam in the middle of the length of the vessel. The welding of the extra circumferential seam in the two-plate construction is merely one item in fabricating cost. In addition, all other operations are doubled, such as handling, laying out, trimming, beveling, heating, crimping the edges, reheating, rolling, assembling, cleaning, chipping, grinding and X-raying. Further extra operations required for the two-piece type are resquaring and beveling edges for the round seam and rerounding the two courses and their fit-up.

The two-plate type of construction, it will be seen from the flow sheet in Fig. 6, must undergo a total of 53 operations, while fabrication of the one-plate type of vessel involves only 23 operations.

The reduction of more than 50% in fabricating operations, by the use of the one-piece construction, results in economies in fabricating cost, in fabricating time and in man-hours required for fabrication. Most important to the fabricator is the possible increase in the plant's productivity, and hence in sales volume without any expenditure for additional plant or machinery.

Costs of Unnecessary Fabricating Operations

What are the costs of the additional fabricating operations made necessary by the use of the two-plate type of construction as compared with the one-plate type of construction for the structures illustrated in Fig. 2?

To obtain reasonably accurate and reliable data on the cost of U-68 class construction, intensive studies have been conducted over a period of several years. While fabricating costs are known to be higher today, the studies were directed toward determining average costs that would represent a fair cross section of the U-68 type of fabricating industry in normal times. Classes of fabrication other than U-68 can eliminate the cost figures herein on operations which are not employed, such as X-raying which is not required on U-69 work, etc.

Table 1 is a typical example of the costs for the extra operations required in the fabrication of a two-plate vessel 2 in. thick. For comparison with the entire cost of the extra operations, the percentage relationship of each operation is given. It will be noted that the actual welding of the extra circumferential seam—simply one step in the over-all fabrication picture—costs $5.60 per foot or only about 29.5% of the entire $19.01 which is the cost per foot of seam of the extra fabricating operations required by the two-plate construction. The one-plate vessel, in 2-in. gage, can effect economy in fabrication cost of about $19 per foot of seam, from which saving, the higher initial cost of the one-piece plate, due to the width extra, must be deducted.

Fabricating Costs and Width Extras

Width extras for carbon steel plates are quoted by the mills in costs per 100 lb. The fabricator generally estimates his costs per foot of seam per vessel. Hence it is difficult to compare two dissimilar figures and know, for example, the relationship between a width extra of $0.05 per 100 lb. and a fabricating cost of $11.66 per foot of seam. To overcome this confusion, it is desirable to translate the width extra per 100 lb. into width extra per foot of seam or per foot of length of plate.

Figures 7 and 8 illustrate this common expression in a simple example of a 56-in. diameter vessel whose circumference is 176 in. with shell length of 108 in., made from a single plate 1 in. thick, 108 in. wide and 176 in. long. The theoretical weight of this plate, including the maximum overweight allowance of 5%, is 385.5 lb. per foot of length of the plate. For the width extra of $0.05 per 100 lb. for a plate 108 in. wide the width extra per foot of length of this plate is $0.19. To justify the use of two plates, the fabricator would have to perform all of the extra operations required by the circumferential seam at a cost of $0.19 per linear foot, or less. A good average figure for U-68 fabrication in 1-in. thick steel plate has been found to be $11.66 per linear foot. Thus, using the one-plate shell shown in Fig. 7, the fabricator pays $0.19 additional per linear foot of steel plate, but saves himself a fabricating cost of $11.66 per linear foot, for a net economy of $11.47 per linear foot. As the length of the circumferential seam is 14 ft. 8 in., the saving of $11.47 per linear foot becomes $168.22 for the entire shell. The width extra was $1.00 per ton; the net fabricating cost saved by paying it amounts to $59.50 per ton.

Converting to other units, the fabricating cost of $11.66 per foot becomes $3.025 per 100 lb. By the one-plate construction the fabricator saves the difference between the width extra of $0.05 per 100 lb. and his additional fabricating cost of $3.025 per 100 lb., or a saving of $2.975 per 100 lb., or $59.50 per ton.

As the width of the plate increases, the width extra per

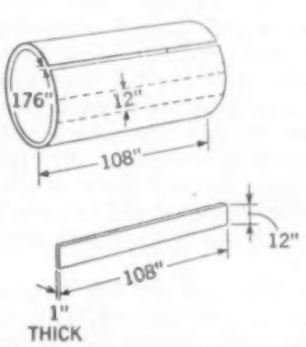


Fig. 7

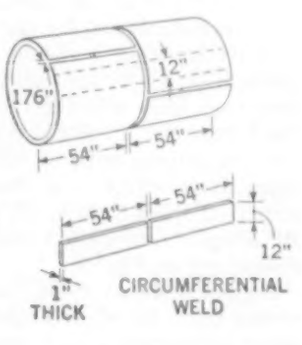


Fig. 8

Table 2—Fabrication and Width Extra Cost per Foot and per 100 Lb., U-68 Construction

PLATE SIZE, IN.	TOTAL WEIGHT, LB	CIRCUMFERENTIAL WELDING				LONGITUDINAL WELDING			
		COST PER FT		COST PER 100 LB		COST PER FT		COST PER 100 LB	
		Fabrication	Width Extra	Fabrication	Width Extra	Fabrication	Width Extra	Fabrication	Width Extra
12 x 108 x ½	190.9	$ 8.51	$ 0.10	$ 4.46	$ 0.05	$ 6.81	$ 0.10	$ 3.57	$ 0.05
12 x 120 x ½	213.2	8.51	0.32	3.99	0.15	6.81	0.32	3.19	0.15
12 x 132 x ½	236.7	8.51	1.78	3.60	0.75	6.81	1.78	2.88	0.75
12 x 144 x ½	259.5	8.51	2.60	3.28	1.00	6.81	2.60	2.62	1.00
12 x 160 x ½	288.2	8.51	3.60	2.95	1.25	6.81	3.60	2.36	1.25
12 x 174 x ½	316.5	8.51	4.75	2.69	1.50	6.81	4.75	2.15	1.50
12 x 192 x ½	349.2	8.51	6.98	2.44	2.00	6.81	6.98	1.95	2.00
12 x 108 x 1	376.4	11.66	0.19	3.10	0.05	9.33	0.19	2.48	0.05
12 x 120 x 1	420.2	11.66	0.63	2.77	0.15	9.33	0.63	2.22	0.15
12 x 132 x 1	464.5	11.66	3.48	2.51	0.75	9.33	3.48	2.01	0.75
12 x 144 x 1	509.2	11.66	5.09	2.29	1.00	9.33	5.09	1.83	1.00
12 x 160 x 1	565.7	11.66	7.07	2.06	1.25	9.33	7.07	1.65	1.25
12 x 174 x 1	618.2	11.66	9.27	1.89	1.50	9.33	9.27	1.51	1.50
12 x 192 x 1	682.2	11.66	13.64	1.71	2.00	9.33	13.64	1.37	2.00
12 x 108 x 2	752.8	19.01	0.38	2.53	0.05	15.21	0.38	2.02	0.05
12 x 120 x 2	840.5	19.01	1.26	2.26	0.15	15.21	1.26	1.81	0.15
12 x 132 x 2	929.0	19.01	6.97	2.05	0.75	15.21	6.97	1.64	0.75
12 x 144 x 2	1018.4	19.01	10.18	1.87	1.00	15.21	10.18	1.49	1.00
12 x 160 x 2	1131.2	19.01	14.14	1.68	1.25	15.21	14.14	1.34	1.25
12 x 174 x 2	1236.4	19.01	18.55	1.54	1.50	15.21	18.55	1.23	1.50
12 x 192 x 2	1364.4	19.01	27.29	1.39	2.00	15.21	27.29	1.12	2.00

100 lb. also increases in steps. A comparison of width extra per foot or per 100 lb. with the fabrication cost per foot or per 100 lb. will determine the optimum plate width.

In Table 2 are given fabrication costs for U-68 construction, per foot, and, per 100 lb., for circumferential welding and longitudinal welding, and the width extras per foot, and per 100 lb., for plate of several gages and widths.

In the case of the plates of $^1/_2$-in. gage in the various widths, it can be seen that the width extras per foot or per 100 lb. never equal the fabrication cost per foot per 100 lb. for circumferential welding and consequently the wide plate is always justified for the fabricating costs given. For example, with $^1/_2$-in. thick plate 192 in. wide, the width extra per foot in circumferential welding is $6.98 compared with a fabricating cost of $8.51 per foot or, on the per 100 lb. basis, the width extra is $2.00 while the fabricating cost is $2.44.

For a 1-in. thick plate, the width at which width extras and fabrication costs balance is about 185 in.; for a 2-in. thick plate, width extras and fabrication costs balance at about 176 in.

As Table 2 indicates, the thickness of plate must always be considered in determining the optimum plate width and the calculation for any given gage cannot be applied directly to other gages in the same width. While these fabrication costs are acceptable averages for U-68 construction, they will differ for other grades of construction; the fabricator should compute his own fabrication costs for comparison with width extras to determine the optimum plate width in a given gage, for any grade of construction other than U-68, always being careful to include all items of fabrication costs as shown in the Fabrication Procedure in Fig. 6.

Figure 9 shows U-68 fabrication cost per 100 lb. converted from the stated fabrication cost per foot, for two-piece construction and also the width extras per 100 lb. The width extras per 100 lb. charged by the steel plate industry are shown in the form of steps for widths over 100 in. Fabrication cost per 100 lb. for the two-piece construction by circumferential welding is shown for certain gages from $^1/_2$ in. to 4 in., inclusive.

The use of Fig. 9 is illustrated by the following ex-

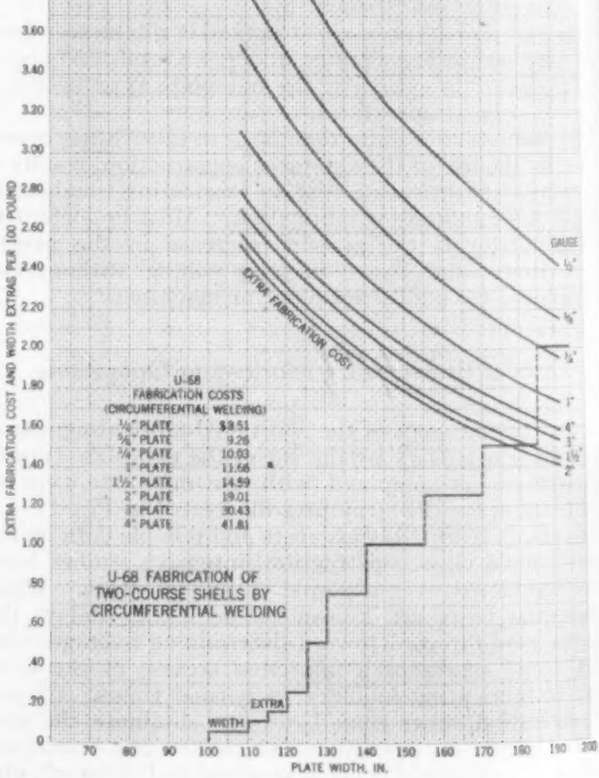


Fig. 9

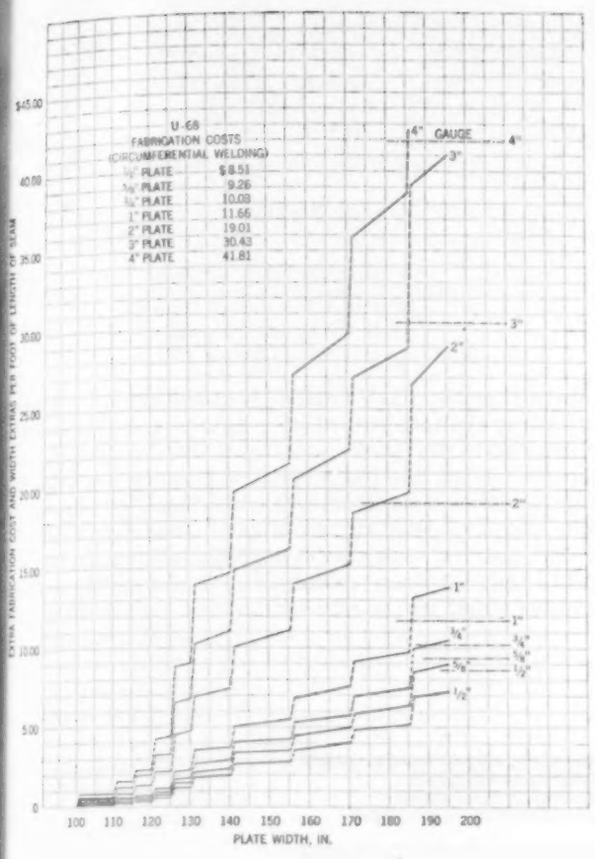


Fig. 10

ample: a two-piece construction by circumferential welding of a shell 144 in. long and 1 in. thick would require two plates 72 in. wide. As shown in Fig. 9 on the 1-in. gage curve, fabrication costs $2.30 per 100 lb. ($11.66 per foot), while one-piece construction from a plate 144 in. wide would involve a width extra of $1.00 per 100 lb. The one-piece construction would save $1.30 per 100 lb. in fabricating cost, or $26.00 per ton of steel plate used in making up the shell.

For a ½-in. thick shell 132 in. wide constructed from two plates 66 in. wide by circumferential welding, Fig. 9 shows that fabrication would cost $3.60 per 100 lb. ($8.51 per foot). One plate 132 in. wide would eliminate the circumferential seam and involve a width extra cost of $0.75 per 100 lb. and result in a saving of $57 per ton in this shell.

The point at which a curve crosses the width extra line in Fig. 9 indicates the plate width for which the width extra equals fabrication cost. On any curve at any width to the left of the width extra line, it is more economical to pay the width extra and use one-piece construction. At any width to the right of the width extra line, it is cheaper to weld two plates to form the shell or cylinder providing man power is available for the extra shop work and production volume is not a major factor.

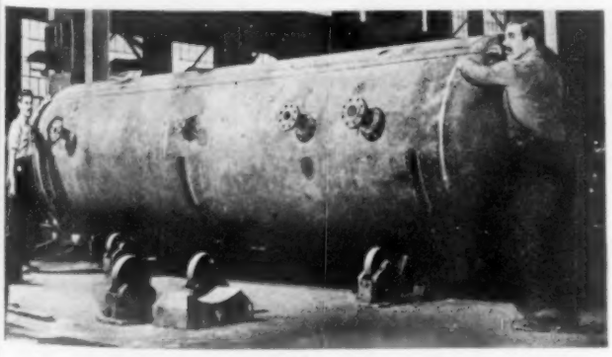


Fig. 11

Figure 9 shows, where ⅝-in. thick plates or lighter are used, it is always more economical to pay the width extra and use one-piece construction, while with ¾-in., 1-in., 3-in. and 4-in. thick plates, one-piece construction is more economical in plate widths up to 185 in. and 1½-in. and 2-in. plates up to approximately 180 in. The location of these points varies with the fabrication cost when grades of construction other than U-68 are used.

While Fig. 9 is based on circumferential welding, it is applicable also to longitudinal welding. As a consequence of the more favorable position in which the welding is performed, the fabrication cost for longitudinal welding is slightly lower, and the curves in Fig. 9 would be somewhat lower for longitudinal welding. Costs for U-68 longitudinal welding as compared with circumferential welding are given in Table 2.

To simplify the comparison of width extras and fabrication cost, the width extras have been converted to cost per foot of length of plate as given in Fig. 10. The fabricating costs are shown on the graph by broken horizontal lines at levels corresponding to the values tabulated on the chart for various gages of plate. These costs are based on the data given earlier. If a fabricating cost differs from the value tabulated, a horizontal line should be drawn at a level representing that cost and the point of intersection with the corresponding width extra curve should be determined. This point gives the optimum width of plate for that fabricating cost.

With a 1-in. plate having a fabricating cost of $11.66 per foot, Fig. 10 indicates that the width of plate should be as great as the design permits up to 185½ in. With a 2-in. plate, at a fabricating cost of $19.01 per foot, the cost crosses the 2-in. width extra curve at a width of 179 in., indicating that the use of any two-plate construction to make up a dimension of less than 179 in. would be more costly than a single-plate construction. A single plate 2 in. thick and 140 in. wide would cost $7.50 per foot for width extra. If the fabricator elected to weld two plates each 70 in. wide to form the 140-in. wide shell, at a cost of $19.01 per foot of length, he would be doing so at the loss of $11.51 per foot of seam. If the length of the plate is in the circumferential direction and the length of the seam is 30 ft., the excess cost in fabricating the two-piece construction would be $345.30 for the vessel.

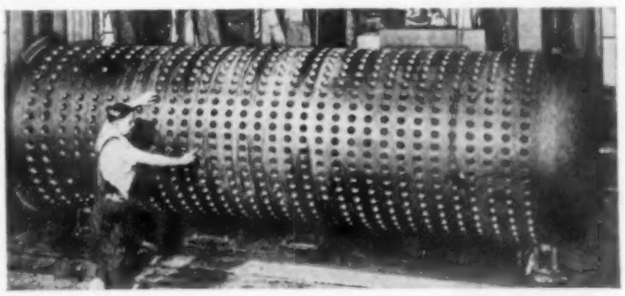


Fig. 12

In like manner, a 2-in. thick plate 108 in. wide would involve a cost of $0.38 per foot of length for the width extra, whereas the fabrication cost for joining two plates each 54 in. wide at $19.01 per foot of length would result in a loss of $18.63 per foot of length. This illustrates the necessity of using the greatest possible width of plate that the fabricating cost will permit, if heavy additional fabrication costs are to be avoided.

It will be noted from Fig. 10 that in ⅝-in. gages and

lighter, and with the fabrication costs given in the chart, the one-piece construction is cheaper than the cost of fabrication for all widths. In $^3/_4$-in. plate, the one-piece construction is more economical up to 190-in. width, the 1-in. plate up to 185$^1/_2$ in., the 2-in. plate up to 177 in., and the 3-in. and 4-in. thicknesses up to 185 in.

Curves for intermediate gages may be plotted as desired on Fig. 10.

An analysis of a recent order for twenty 48-in. and twenty 54-in. vessels is enlightening. These shells (shown in their finished state in Figs. 11 and 12) might have been ordered as follows:

48-in. Diameter Vessels

20 Plates 157$^1/_2$ x 87 x 1$^3/_4$ in.
20 Plates 157$^1/_2$ x 85 x 1$^3/_4$ in.

54-In. Diameter Vessels

20 Plates 176$^3/_4$ x 91 x 1$^{15}/_{16}$ in.
20 Plates 176$^3/_4$ x 93 x 1$^{15}/_{16}$ in.

After comparison of width extras and fabrication costs, the fabricator placed his order as follows:

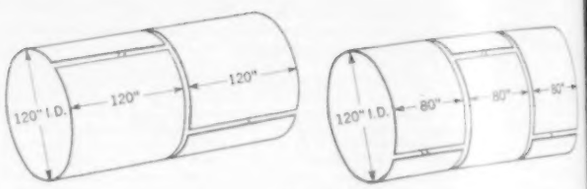


Fig. 13

48-In. Diameter Vessels
20 Plates 171 x 157$^1/_2$ x 1$^3/_4$ in.
54-In. Diameter Vessels
20 Plates 183 x 176$^3/_4$ x 1$^{15}/_{16}$ in.

With the two-plate construction the extra fabricating cost, using the fabricator's own figures, was estimated to average $436 per shell, or a total for the 40 vessels of $17,440. With one-plate construction the extra for the 40 wide plates at width extras of $1.25 per 100 lb. for the 157$^1/_2$-in. wide plate and $1.50 per 100 lb. for the 176$^3/_4$ in. wide plates, and the overweight allowance, totaled $9853. By 20 min. calculation, a net saving was effected of $7587 in the fabrication cost for the 40 vessels.

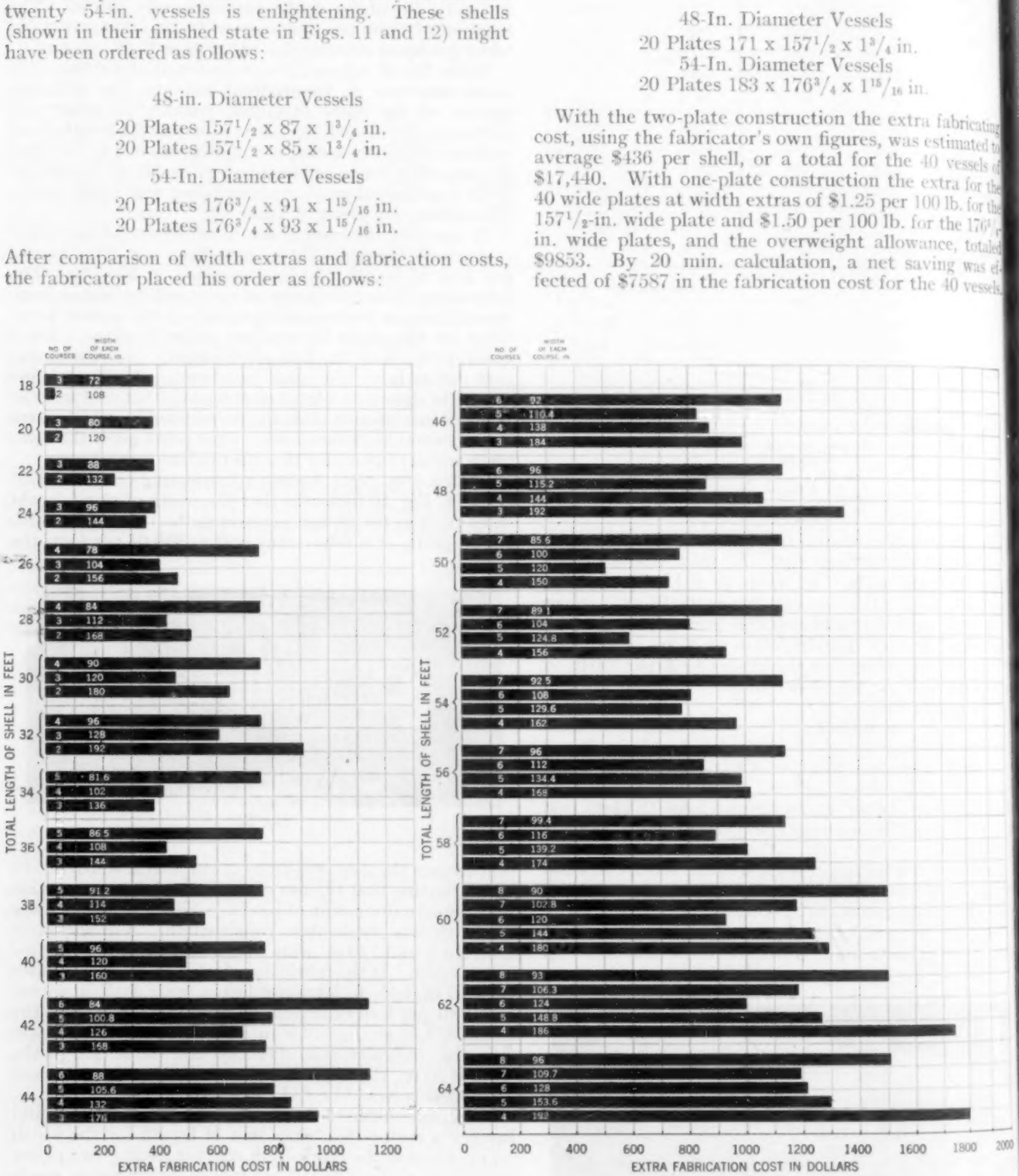


Fig. 14—1-In. Gage

Plotted values of the variation in cost with the number of courses for a 120-in. I.D. shell for lengths from 18 to 64 ft.
The shell is made of 1-in. gage plate and the cost for a circumferential weld is taken as $11.66 per foot (U-68 type construction).
The stated costs include only width extras, overweight allowance and the additional fabrication cost resulting from the use of more courses than the minimum number which is required by the widest available plates.

In addition, by eliminating the extra fabricating operations which would have been required by two-piece construction, fabricating time on the 40 vessels was reduced by 5800 man-hours, or the equivalent of a 48-hr. work week of 121 men. There results a corresponding increase in shop productivity without additional expenditure for plant or equipment.

The simplicity of the construction used in these 40 vessels, as shown in Figs. 11 and 12, indicates the freedom afforded the designer of the vessels in the location of tube holes and other openings without interference by a circumferential weld.

Multiple-Course Construction

A similar analysis may be made for a cylindrical vessel in which its length is greater than the widest plate which can be rolled, namely 195 in.; in such a case, the length of the plate, as rolled, forms the circumference of the vessel, and the width of the plate becomes part of the length of the shell. For example, the diameter may be 10 ft. and the length 18 to 26 ft. Two-piece and three-piece constructions of such a vessel are shown in Fig. 13. With three-piece constructions an additional circumferential seam has to be fabricated; the additional fabricating cost is shown in Fig. 14.

A 20-ft. long drum may be made of two courses each 120 in. wide or three courses each 80 in. wide, as shown in Fig. 13. The 120-in. plates save the fabricating cost of one seam, and cost a total width extra for the two plates of $59.30. With three 80-in. plates, 1 in. thick, the cost of making the additional circumferential seam is $11.66 per foot or a total of $380.93. All figures used herein include normal overweight allowances, metal and width extras, involved in the overweight. The wide plate construction saves the difference between these two costs, or $321.63 per vessel. In addition 127 man-hours have been saved in fabricating the vessel with wide plates.

With increase in the lengths of the shells wider plates are required for the two-piece construction and the width extra cost may approach the extra fabricating cost for the three seams. However, in each case 127 man-hours of fabricating time are saved on each vessel by the use of the two-plate construction. The maximum width used economically for 1-in. thick plate in the two- or three-course construction is about 155 in. It is uneconomical to use plates under 100 in. wide in any of the combinations.

The economic advantage of wide plates varies with the number of courses used in a vessel. As the number increases beyond three courses, the actual saving in cost, effected through the use of wider plates, becomes less. This results from the fact that the widest possible plates carry high width extras and cost so much that considerable fabrication can be done for less than the width extra cost. It is nevertheless always true that the use of wider plates reduces the man-hours of labor required for fabrication of the vessel, thereby speeding output and increasing production volume and plant capacity without additional investment in plant or equipment.

In Fig. 14, the four vessels, varying from 26 ft. to 32 ft. in length, may be made up of either two, three or four courses. The bar charts show the total cost either of width extra or of extra fabrication, or a combination of both. The three-course construction is then seen to be cheapest. An example of the procedure in calculating is as follows: The 30-ft. vessel can be made of two 180-in. courses, three 120-in. courses, or four 90-in. courses. The two-course vessel has a total width extra cost of $651.16. The three-course vessel reduces the total width extra to $88.95, and the extra seam, at $11.66 per foot for the vessel's 31 ft. 6 in. circumference, costs $369.62, making a total of $458.57. The three-course construction saves $192.59 over two courses. In the four-course construction there is no width extra but two extra seams must be made at a cost of $758.64. The cost of the four-course construction is greater than for two courses, and much greater than for three courses.

Figure 14 also shows the cost for shell lengths from 34

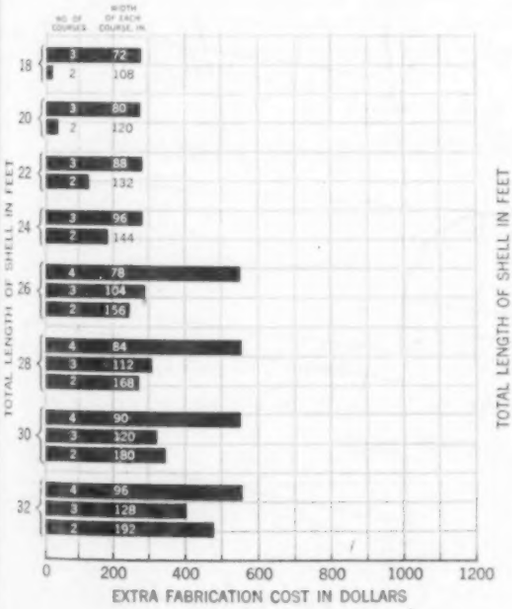


Fig. 15—$^1/_2$-In. Gage

The shell is made of $^1/_2$-in. gage plate and the cost for a circumferential weld is taken as $8.51 per foot (U-68 type construction).

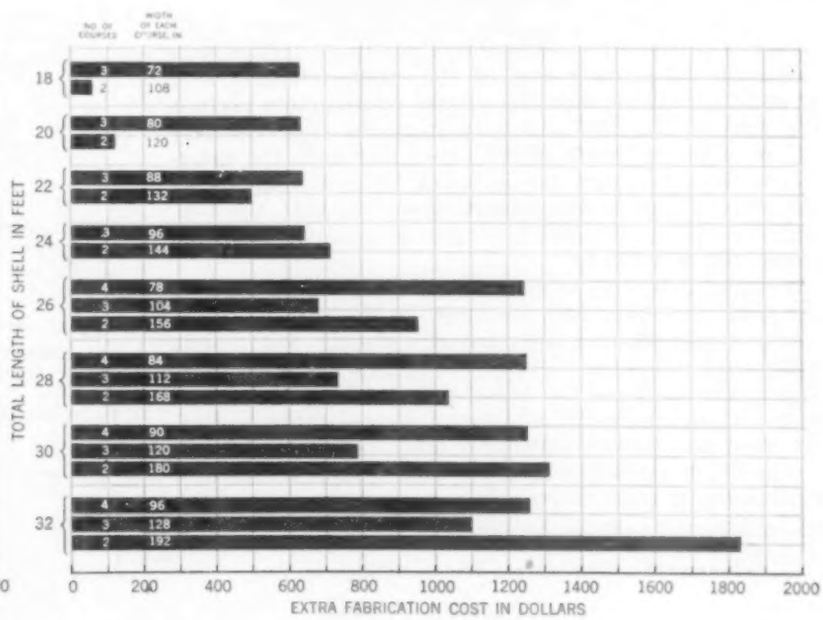


Fig. 16—2-In. Gage

The shell is made of 2-in. gage plate and the cost of a circumferential weld is taken as $19.01 per foot (U-68 type construction).

Plotted values of the variation in cost with the number of courses for a 120 in. I.D. shell for lengths from 18 to 32 ft. The stated costs include only width extras, overweight allowance and the additional fabrication cost resulting from the use of more courses than the minimum number which is required by the widest available plates.

to 64 ft. for a diameter of 120 in. and 1-in. gage. The selection of the optimum construction is not affected by the diameter of the shell since both the total width extra costs and the circumferential seam fabrication costs vary in direct proportion to the diameter.

The most economical width of plate can be seen from these bar charts. For the 50-ft. vessel, the five-course construction with 120-in. plates, which require an additional circumferential seam as compared with the four-course construction, is lowest in cost. The four-course unit involves a total width extra of $736.44; the five-course construction costs $517.87 for width extra and additional fabricating cost. The six-course vessel involves an extra welding cost of $739.24 due entirely to the cost of the two additional seams plus $36.36 for the extra metal involved as overweight for a total of $775.60. The sum of $1141.13 for the seven-course unit is the cost of the three extra seams.

Figure 14 shows that the four-course construction is cheapest between the lengths of 36 ft. up to and including 42 ft., and then the five-course type becomes most economical. As the length of the vessel increases, the six-course structure becomes the cheapest, at a length of about 56 ft. and this gives way to a seven-course structure at about 64 ft. These optimum constructions correspond to plate widths between 100 in. and 130 in. Increasing the plate width over 130 in. increases the width extras more than it decreases the fabricating cost. The designer's problem is to find that combination of width extras and fabricating operations which produces the lowest cost of construction.

Figure 14 also emphasizes the fact that plates less than 100 in. wide are uneconomical for such a structure. For 1-in. gage where one or two courses are involved, plates up to 185 in. may be used to advantage; where the choice of construction lies between two or three courses, plates up to 155 in. are most economical; where three or more courses are involved, the economical limit is scarcely more than 130 in.

Similar cost data for 1/2-in. and 2-in. gage are presented, in Figs. 15 and 16, and indicate analogous relationships for vessel construction in these gages.

Considering the 1/2-in. gage and 10-ft. diameter, if the choice is between two wide plates and three narrow ones (with the fabrication cost of the circumferential weld at $8.51 per foot), the three-course construction exceeds the cost of the two-course type up to approximately 175 in. As the length of the vessel increases, the three-course vessel is seen to be lower in cost than either the two- or four-course construction. As with the 1-in. gage the optimum width for three or more courses is between 100 and 130 in.

For the 2-in. gage combinations as shown in Fig. 16, the trend is similar but the limits in the two- or three-course vessel constructions are at a slightly lower plate width than either the 1/2-in. or 1-in. gages, namely, 140 in. Where the length of the vessel may be made up of two, three or four courses from plates of corresponding widths, the most economical width does not exceed 130 in.

The following table summarizes the results for different thicknesses of plate and number of courses:

Maximum Economical Width of Course, In.

Number of Courses	1/2-In. Plate	1-In. Plate	2-In. Plate
1 or 2	195	185	176
2 or 3	175	155	140
3 and more	130*	130*	130*

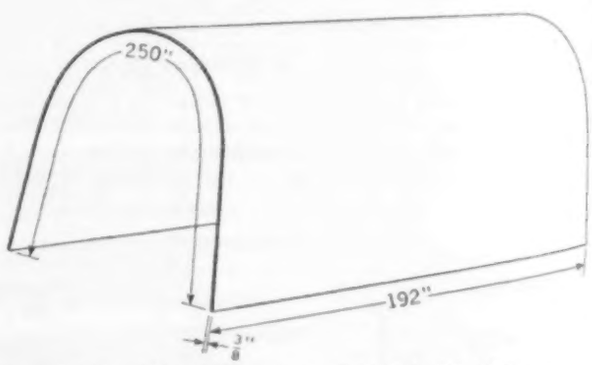
* Where the saving in man-hours of fabrication time is important, these widths may be substantially increased.

Every combination should use plates over 100 in. in width for the maximum economy.

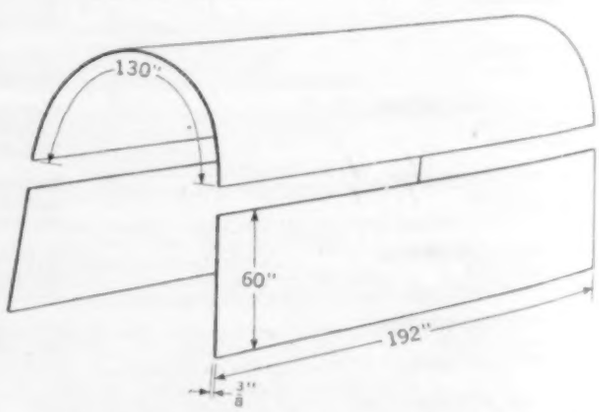
Saving Man-Hours in Fabrication

In long vessels constructed of multiple courses, plates more than 130 in. wide appear to be at a disadvantage if cost figures alone are taken into account. However, the other benefits derived from their use, such as the reduction of man-hours and of the equipment needed for fabrication, may offset the higher cost of wider plates. Consider a cylindrical shell 30 ft. long of 1/2-in. gage. It may be made of two plates each 180 in. wide, or three plates 120 in. wide with an extra weld seam, or four plates 90 in. wide with two extra weld seams. For the two-course shell the only extra cost is the width extra applicable to 180-in. plates, in this instance totaling $343.66. The three-course shell requires an additional seam costing $268.49 and has a width extra of $51.96 or a total extra cost of $320.45. The three-course shell saves only $23.21 in comparison with the two-course shell, but requires 89 more man-hours in fabrication to effect this small economy, or two men were employed for a 45-hr. week to save $23.21. If these two men had been employed in the production of additional vessels a greater income would be obtained as a result of the increase in production.

In like manner, the 64-ft. long drum of 1-in. thick plate shown in Fig. 14 indicates the seven-course combination to be lowest in cost. It is less costly than the



1 Plate 250 x 192 x 3/8 in. = $122.66 Width Extra



1 Plate 192 x 130 x 3/8 in. =	$ 18.04 Width Extra
2 Plates 192 x 60 x 3/8 in. =	1.84 Overweight
32 Ft. welding at $7.20/ft. =	230.40 Fabrication
Total	$250.28
Cost of One-Plate Width Extra	122.66
Net Saving with One Plate	$127.62

Fig. 17

Table 3—Variation of Cost with Width of Plate of Locomotive Fireboxes

A Thickness of 3/8 In. Is Assumed and a Fabricating Cost of $7.20 per Linear Foot

Girth, 200 in.

Firebox Length, in.	Single Course		Three Course		
	Size, in.	Cost	1 Crown, in.	2 Sides, in.	Cost
108	200 x 108 x 3/8	$ 4.08	120 x 108 x 3/8	108 x 40 x 3/8	$132.56
120	200 x 120 x 3/8	7.89	120 x 120 x 3/8	120 x 40 x 3/8	149.32
132	200 x 132 x 3/8	27.88	132 x 120 x 3/8	132 x 40 x 3/8	164.23
144	200 x 144 x 3/8	39.17	144 x 120 x 3/8	144 x 40 x 3/8	179.15
160	200 x 160 x 3/8	52.70	160 x 120 x 3/8	160 x 40 x 3/8	199.08
174	200 x 174 x 3/8	68.77	174 x 120 x 3/8	174 x 40 x 3/8	216.50
192	200 x 192 x 3/8	98.12	192 x 120 x 3/8	192 x 40 x 3/8	238.88

six-course vessel by approximately $24 and cheaper than the five-course one by about $109. However, compared with the four-course construction (which is undoubtedly too expensive except under unusual conditions), the extra fabricating time is 123 hr. for the five-course unit, 246 hr. for the six-course unit and 369 hr. for the seven-course vessel.

The waste of the additional 123 man-hours needed to effect the saving of $24.22 in money by using the seven-course vessel is only outweighed in careless estimating by the saving of $109 at the cost of 246 more man-hours of fabrication time by failing to select the five-course 154-in. wide plates. The estimating engineer should consult his man-power reserve as well as his firm's cash in selecting the right combination of plates in the design of a vessel.

One fabricator, by the use of one 154-in. wide plate instead of two 77-in. wide plates, increased his production from 15 vessels to 20 vessels per week, or an increase in production of 33 1/3% without additional investment in men, machinery or plant.

Field Inspection of Joints

Where welded joints in vessels have to be inspected in the field after certain periods of operation, wide plates, by reducing the number of seams, keep such service costs at a minimum.

Table 5—Variation of Cost with Width of Plate of Locomotive Fireboxes

A Thickness of 3/8 In. Is Assumed and a Fabricating Cost of $7.20 per Linear Foot

Girth, 300 in.

Firebox Length, in.	Single Course		Three Course		
	Size, in.	Cost	1 Crown, in.	2 Sides, in.	Cost
108	300 x 108 x 3/8	$ 6.11	160 x 108 x 3/8	108 x 70 x 3/8	$134.07
120	300 x 120 x 3/8	11.82	160 x 120 x 3/8	120 x 70 x 3/8	151.64
132	300 x 132 x 3/8	41.82	160 x 132 x 3/8	132 x 70 x 3/8	182.18
144	300 x 144 x 3/8	58.75	160 x 144 x 3/8	144 x 70 x 3/8	205.74
160	300 x 160 x 3/8	79.05	160 x 160 x 3/8	160 x 70 x 3/8	235.96
174	300 x 174 x 3/8	103.16	174 x 160 x 3/8	174 x 70 x 3/8	256.59
192	300 x 192 x 3/8	147.19	192 x 160 x 3/8	192 x 70 x 3/8	281.13

Allowable Overweight of Plates

The "allowable overweight" of steel plates has sometimes been considered as an objection to the use of wide plates. As the width of the plate increases up to 168 in. the allowance for overweight likewise increases. From 168 to 195 in. the percentage overweight allowance remains constant.

The cost of wide plates is increased by this overweight, but this increase is a small fraction of the savings in fabricating costs and man-hours resulting from the use of wide plates. The following example illustrates this point in a vessel that could be built either of two plates 240 x 144 x 1/2 in. or of three plates 240 x 96 x 1/2 in. The increased overweight allowance for the two 144-in. plates is $20.54, including the base price, quality extra and width extra involved as a result of this overweight. This overweight cost plus the width extra cost for the two 144-in. plates over that of the two 96-in. wide plates is $118.48. The extra fabricating cost plus overweight for the three-course construction is $178.78. The 144-in. plates, despite the greater overweight allowance, show a net saving of $60.30 per vessel.

Table 4—Variation of Cost with Width of Plate of Locomotive Fireboxes

A Thickness of 3/8 In. Is Assumed and a Fabricating Cost of $7.20 per Linear Foot

Girth, 250 in.

Firebox Length, in.	Single Course		Three Course		
	Size, in.	Cost	1 Crown, in.	2 Sides, in.	Cost
108	250 x 108 x 3/8	$ 5.09	130 x 108 x 3/8	108 x 60 x 3/8	$133.29
120	250 x 120 x 3/8	9.85	130 x 120 x 3/8	120 x 60 x 3/8	150.27
132	250 x 132 x 3/8	34.84	132 x 130 x 3/8	132 x 60 x 3/8	172.07
144	250 x 144 x 3/8	48.96	144 x 130 x 3/8	144 x 60 x 3/8	187.71
160	250 x 160 x 3/8	65.88	160 x 130 x 3/8	160 x 60 x 3/8	208.59
174	250 x 174 x 3/8	85.97	174 x 130 x 3/8	174 x 60 x 3/8	226.81
192	250 x 192 x 3/8	122.66	192 x 130 x 3/8	192 x 60 x 3/8	250.28

Width Extras and Low-Alloy Steels

The preceding considerations determining optimum plate widths apply equally to plates of low-alloy steel. The width extras for such steels are somewhat higher in proportion to their fabricating costs; the maximum economic width is found to be approximately 10% lower than the carbon steels.

One-Piece Crown and Side Construction in Locomotive Fireboxes

Wide plates always result in savings in money, time and man-power when used in the design of one-piece crown and side construction of locomotive fireboxes. The widest and longest plate that can be produced shows definite economic advantage in such structures. In the usual range of sizes

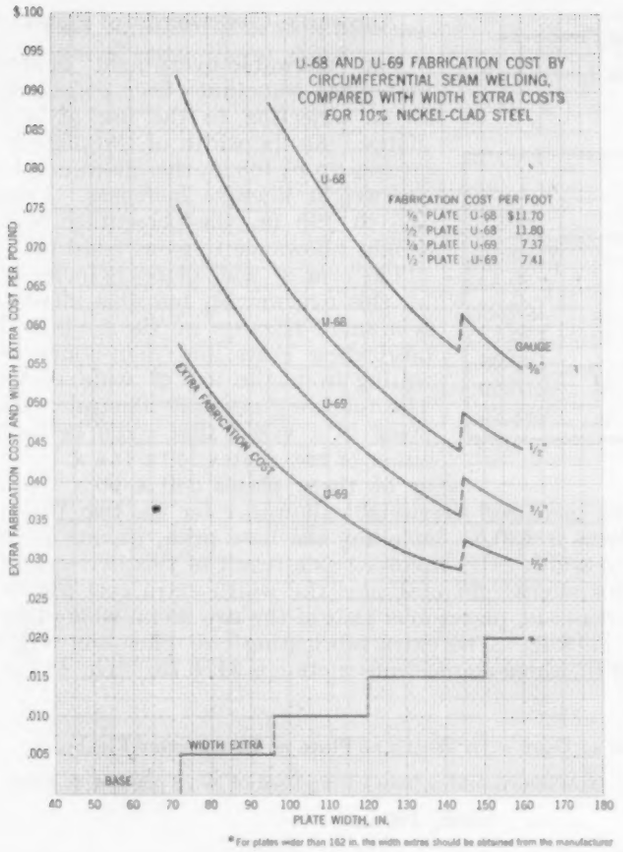


Fig. 18

the saving by the use of one-piece construction as compared with three-plate construction is about $140 per unit.

The use of a wide plate up to 192 in. wide and 250 in. long requires the handling, rolling and assembling of one plate only, while the three-piece construction requires the laying out, forming, beveling and welding of two extra joints. The cost of such work is always in excess of the width extra involved for the wider plate. An example is shown in Fig. 17. The extra fabricating cost, overweight cost and width extra cost of the three-piece crown and side is $250.28, while the one-piece unit involves a width extra of $122.66. The net saving with the one-piece unit is $127.62, or $50.05 per ton of firebox plate.

In one-piece crown and side construction the width of the plate generally makes up the length of the firebox, and the length of the plate develops the girth dimension.

Tables 3, 4 and 5 show the cost of the single plate as compared with the three-plate type with varying girth dimensions. In Table 4, for example the crown and sides with a girth dimension of 250 in. and a length of 174 in. can be made from one plate 250 x 174 x $^3/_8$ in. The three-piece unit requires one plate 174 x 130 x $^3/_8$ in., and two plates 174 x 60 x $^3/_8$ in. The width extra cost of the one-plate unit is $85.97. For the three-piece unit, the extra cost of fabricating plus the width extra for the 130-in. plate is $226.81. The net saving effected by the one-piece unit is $140.84. In addition, the one-piece unit required about 75 man-hours less time in its fabrication.

Plate Widths in Clad Steels

The use of wide plates of clad steels shows even greater savings than with the carbon steels, as both the base price of the material and the fabricating costs are higher in proportion to the width extras for the clad steels. The fabricating costs are increased by the care necessary in working the clad materials, and by the cost of the accessory metals such as welding electrodes.

With clad steels, the widest possible plate should always be used; all known examples show savings.

A comparison of width extras and welding costs for 10% nickel-clad steel, converted to costs per pound of plate material used, is shown in Fig. 18. For example

Table 6
Width Extras

All Plates, Rectangular or Otherwise

Applies to plates $^1/_4$ in. or over in thickness, and when ordered to weight per square foot, not less than 11 lb.

Widths, In.	Per 100 Lb.
Over 100 to 110, incl.	$0.05
Over 110 to 115, incl.	0.10
Over 115 to 120, incl.	0.15
Over 120 to 125, incl.	0.25
Over 125 to 130, incl.	0.50
Over 130 to 140, incl.	0.75
Over 140 to 155, incl.	1.00
Over 155 to 170, incl.	1.25
Over 170 to 185, incl.	1.50
Over 185 to 195, incl.	2.00
Over 195	On Application

Width Extras—Wide Light Plates

All Plates, Rectangular or Otherwise

Applies to plates under $^1/_4$ in. thick or less than 11 lb. per square foot.

Widths, In.	Per 100 Lb.
Over 72 to 84, incl.	$0.10
Over 84 to 96, incl.	0.20
Over 96 to 100, incl.	0.30
Over 100 to 110, incl.	0.40
Over 110 to 115, incl.	0.45

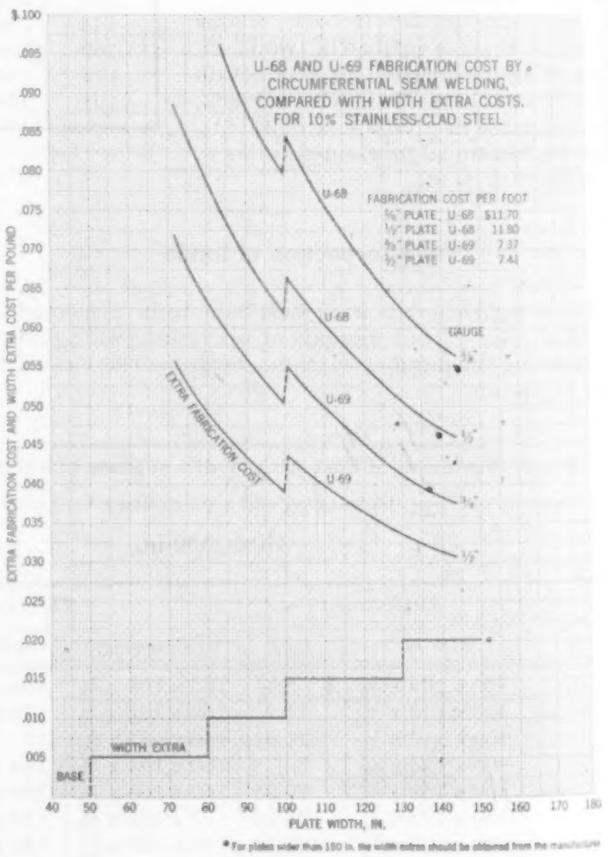


Fig. 19

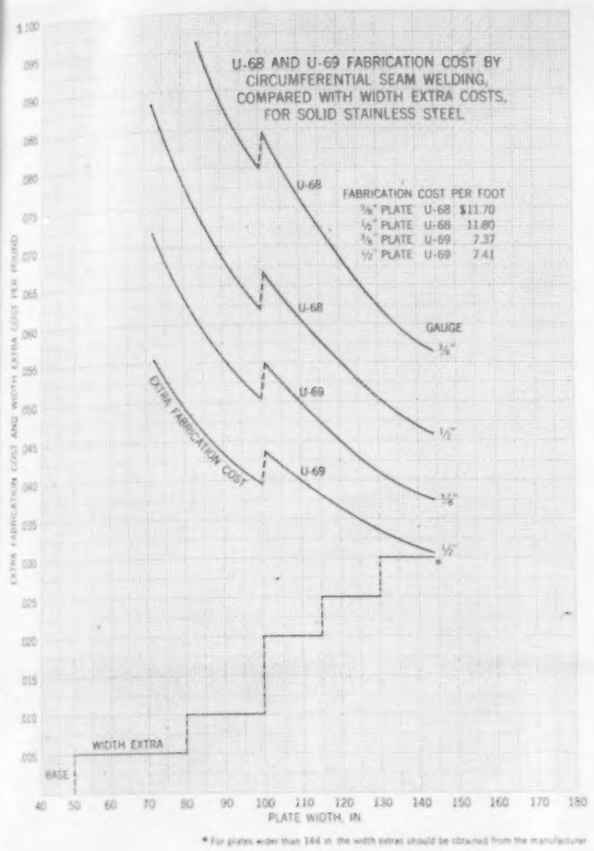

U-68 AND U-69 FABRICATION COST BY CIRCUMFERENTIAL SEAM WELDING, COMPARED WITH WIDTH EXTRA COSTS, FOR SOLID STAINLESS STEEL
FABRICATION COST PER FOOT
3/16" PLATE U-68 $11.70
1/2" PLATE U-68 11.80
5/16" PLATE U-69 7.37
1/2" PLATE U-69 7.41
U-68
U-68
U-69
U-69
GAUGE
3/16"
1/2"
5/16"
1/2"
EXTRA FABRICATION COST
WIDTH EXTRA
BASE
EXTRA FABRICATION COST AND WIDTH EXTRA COST PER POUND
PLATE WIDTH, IN
40 50 60 70 80 90 100 110 120 130 140 150 160 170 180
* For plates wider than 144 in. the width extras should be obtained from the manufacturer

Fig. 20

with a $^1/_2$-in. gage plate fabricated in accordance with U-68 requirements at $11.80 per foot, the extra fabricating cost using two 42-in. plates to make up an 84-in. plate by welding would cost $0.078 per pound; a single plate 84 in. wide would cost $0.005 per pound in width extras. This results in a saving of $0.073 per pound or almost half of the base price of the material, in addition to the other advantages of time, and man-hours. As a further illustration, a single plate 108 in. wide would have a width extra cost of $0.010 per pound and the fabricating cost to join two 54-in. plates of $^1/_2$-in. gage and built by U-69 construction would cost almost $0.038 per pound. The saving by using the single wide plate would be $0.028 per pound.

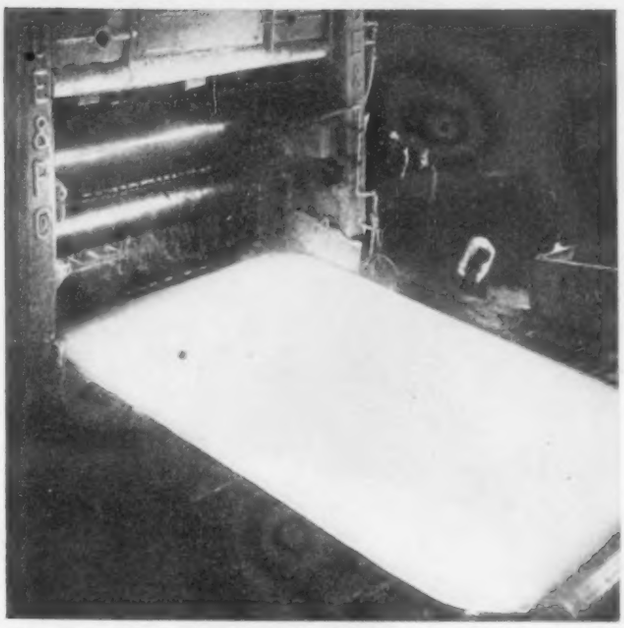
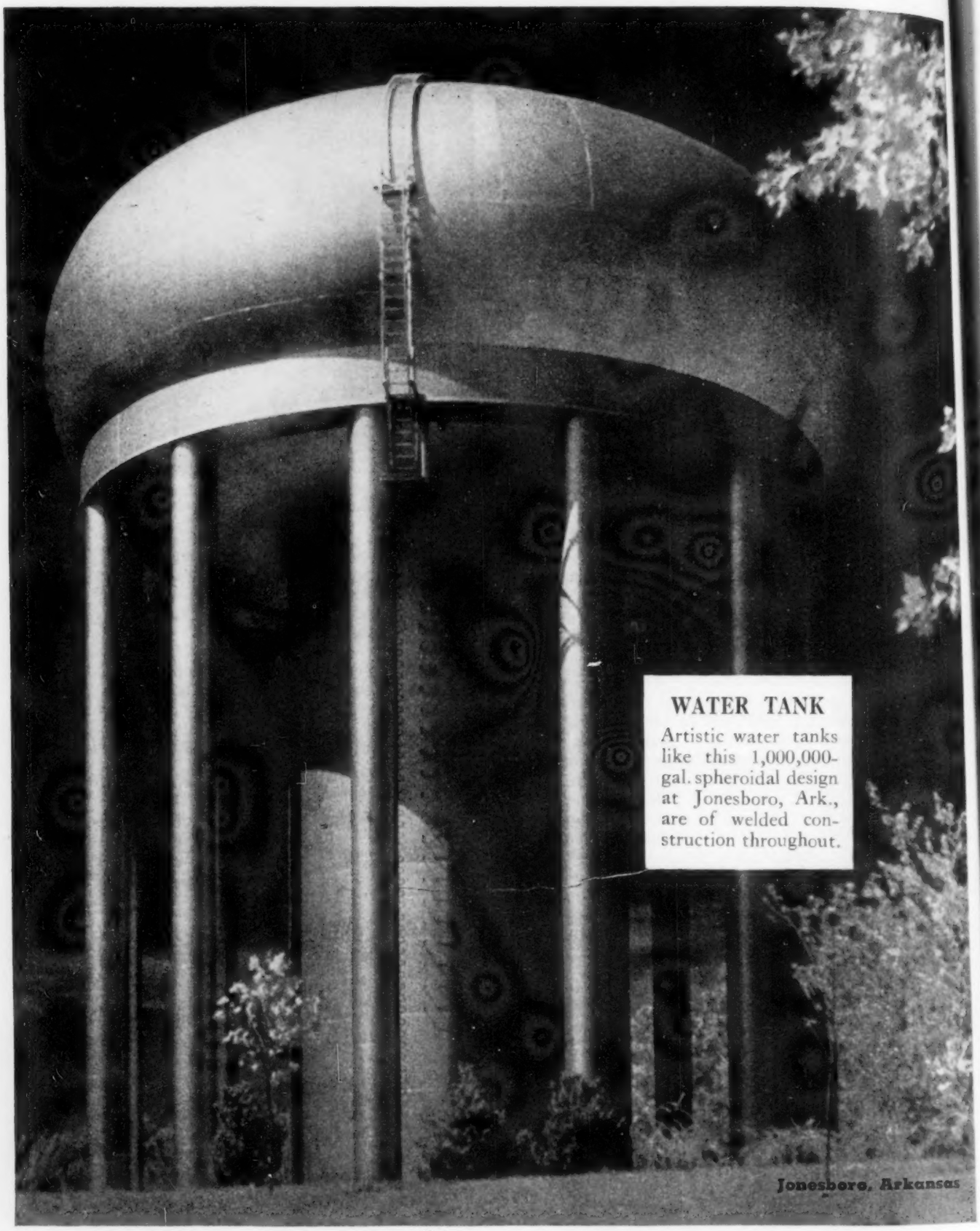


Fig. 21—Rolling a 195-In. Wide Steel Plate on Lukens 206-In. Mill, the World's Largest Plate Mill

Similar curves for stainless-clad steels are given in Fig. 19. From these it may be seen that a single plate 108 in. wide can be purchased for a width extra of $0.015 per pound; two narrow plates, 54 in. wide, of $^3/_8$-in. gage, have a U-69 fabricating cost of $7.37 per foot and would cost $0.0509 per pound to join together. The use of the wide plate effects a saving of $0.0359 per pound as well as the savings in shop time and use of equipment.

Solid Stainless and Nonferrous Metals

The high-priced solid stainless and nonferrous metals show similar savings for wide plates. Figure 20 gives data on width extras and extra fabricating costs for plates of stainless steels. A single wide plate 84 in. wide and $^1/_2$-in. gage may be purchased for a width extra of $0.01 per pound. Two narrow plates each 42 in. wide and welded to form a plate 84 in. wide would cost $0.0469 per pound for the extra fabrication required by U-69 construction at $7.41 per foot. The saving due to wide plates in this case is $0.0369 per pound.


WATER TANK
Artistic water tanks like this 1,000,000-gal. spheroidal design at Jonesboro, Ark., are of welded construction throughout.
Jonesboro, Arkansas

CHICAGO BRIDGE & IRON COMPANY

Chicago 4.....2455 McCormick Bldg.
New York 6.....3398—165 Broadway Bldg.
Cleveland 15.....2282 Guildhall Bldg.
Havana.....Edificio Abreu 402
Birmingham 1.....1907 North 50th Street
Tulsa 3.....1654 Hunt Bldg.
Greenville.....York Street
Houston 1.....5621 Clinton Drive
Washington 4.....703 Atlantic Bldg.
Philadelphia 3.....1668-1700 Walnut Street
Los Angeles 14.....1471 Wm. Fox Bldg.
San Francisco 5.....1097 Rialto Bldg.

Fabricating plants in CHICAGO, BIRMINGHAM, and GREENVILLE, PA.

Procedure Control of Automatic Welding Processes*

By A. E. Bedell and J. B. Quigley†

Introduction

IT IS the opinion of the writers, which we feel sure is held by many others, that among the many papers that are presented at a meeting of this nature, there is a place for at least one that deals broadly in fundamentals; but at the same time is based upon actual production experience extending over a period of years. Strictly research investigations confined to a particular problem or to a specific phase of a broad investigation are essential to progress, and the pooling of knowledge gained thereby is of inestimable value; not only to us as individuals but to industry as a whole.

On the other hand, whether we fully realize it or not, the development of a theory into a practical, workable and economically sound production method is only accomplished by a somewhat analogous series of studies and investigations; sometimes greater in scope in regards to time, money and brain power expended than is required by many strictly research problems. It should naturally follow that knowledge so gained, often only obtainable by the "cut and try" method, will be not only of interest but of value to those who have any concern in or knowledge of the subject; whether from the theoretical or the practical viewpoint.

That there is an unusual amount of interest in automatic welding processes is unquestionable, and this is rightly so. The unprecedented publicity given to welding accomplishments, both in the technical and nontechnical press, during the last few years is but one evidence of this fact. Actually, I suppose that the very mass of such literature should discourage anyone from further adding to it, but the fact remains that either much of this publicity is of doubtful value or it has not been absorbed by the right people, because our contacts with many persons who should know better have often indicated either a considerable lack of knowledge or even an actual ignorance of the fundamentals of automatic welding.

In theory automatic machine welding is not only simple, but it has been proven in practice. But, as we all know from what is often painful experience, there is usually a long road to travel before a theory becomes an economical and generally accepted practice. A theory must be thoroughly investigated, innumerable tests made, knowledge gained often at great expense and through repeated failures and actual commercial work carried out over an extended period of time before it can be considered a proven process. But, once this stage has been reached, the benefits as well as the limitations, of such an art should be a matter of public knowledge.

* Presented at the Twenty-Fifth Annual Meeting, A.W.S., Cleveland, Ohio, Oct. 16 to 19, 1944.

† Chief Engineer and Welding Supervisor, Graver Tank & Mfg. Co., Inc., E. Chicago, Ind.

General Discussion

Since our discussion is to be confined to such automatic machine welding processes as are suitable for heavy plate fabrication of mild and certain alloy steels, all such processes may be divided into three general types: (*a*) shielded metallic arc, (*b*) completely shielded submerged arc and (*c*) carbon arc-shielded. We ourselves have successfully used in the past all three of these methods in our shops, and are at the present time utilizing two of these methods on current production work.

Time does not permit, nor is it necessary considering that probably most of us present are at least superficially familiar with such welding processes, detailed discussion of the design features or the relative merits of the numerous commercial automatic welding machines that are available on the market today and that fall within one of these three classifications, although naturally differing in construction or operation. We will later discuss briefly the outstanding advantages and disadvantages of each of these general types on various classes of work.

Both the shielded metallic arc and completely shielded submerged arc systems operate on the same fundamental principle—that of automatically striking and holding the arc between the electrode and the part to be welded. Since, with a given electrode and parent metal, the arc voltage is a function of the arc length, it is only necessary to provide a means of feeding the electrode toward the arc at a rate which will automatically compensate for the deposited portion of the electrode and a constant arc length is thus maintained.

Although it naturally follows that there are many successful methods of fulfilling this condition, all automatic arc systems must of necessity perform three essential duties: (*a*) feed the electrode, (*b*) conduct an electrical current into the electrode and (*c*) provide a method of control for striking and maintaining the proper arc length. The carbon arc method utilizes direct current, usually of the variable voltage type, the polarity of the carbon being negative and the work positive. For shielding, the metallic arc process uses a coated wire, usually with some special provisions for overcoming the insulating effect of the coating. The carbon arc process has provisions for automatically feeding fibrous or powdered shielding material, and the submerged uses a bare wire and applies a granular flux, the entire welding action taking place beneath this flux.

In comparing the relative advantages and disadvantages of each of these three automatic welding processes it must be understood that such comparison is based only and entirely on experience gained within our own shops. It does not necessarily follow that the same or the relative importance of the various factors will hold true elsewhere, as they are dependent upon the character and nature of the work to be performed,

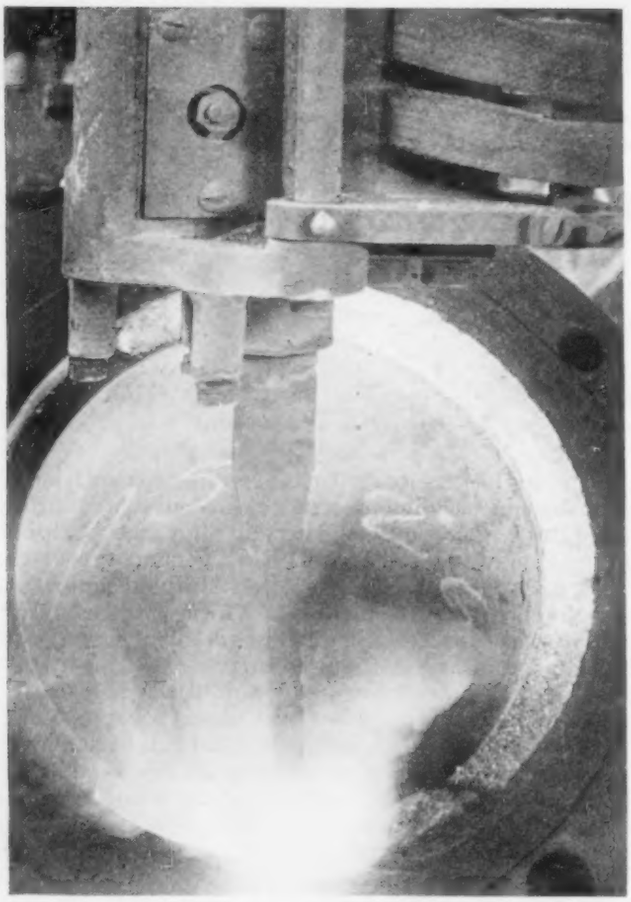


Fig. 1—Fillet Weld on Flange (Flat Position) Shielded Metallic Arc Process

versatility required and other such obvious considerations.

The shielded carbon arc process is particularly applicable where the work calls for welds on a production basis and where the character of the work is reasonably uniform. It is satisfactory for aluminum and its alloys. Plate preparation is simplified, square-edge plates normally being used and hence it is ideal for square butt joints. It is advantageous in edge welding, where no metal is to be added. No back chipping is required. However, this process is limited to plates $^3/_4$ in. or under in thickness and it is a very difficult one to adopt to fillet welding.

Shielded metallic arc welding, actually being a duplication of manual welding under automatic conditions, is adaptable to plates of any thickness and for most all ferrous alloys, and is ideal for single-pass fillet welds up to $^1/_2$ in. But it requires the use of coated wire, and multiple-pass welding is necessary for plates in excess of $^1/_8$-in. thickness and thus it is comparatively slow. Back chipping is necessary.

The submerged arc system can be used either as a multiple- or single-pass process and for most ferrous alloys. No special plate preparation is required in plate thicknesses of $^1/_2$ in. or less as butt joints are satisfactory, and with proper plate preparation no back chipping is required under any conditions. Excellent penetration can be secured at high speeds. It is successful for light or heavy butt joints and on certain types of fillet joints. It is, however, restricted to joints in a relatively horizontal position; no visual inspection is possible while the weld is being made and excess flux must be collected.

Physical properties of welds made with any of these processes meet with the requirements of the A.S.M.E. and the A.P.I.-A.S.M.E. codes as well as with all insurance inspection specifications. While varying with the individual job, as far as our character of work is concerned, we have found the shielded metallic arc process approximately 20 to 30% faster, carbon arc 60% faster and submerged arc 80% faster on the average, than manual welding.

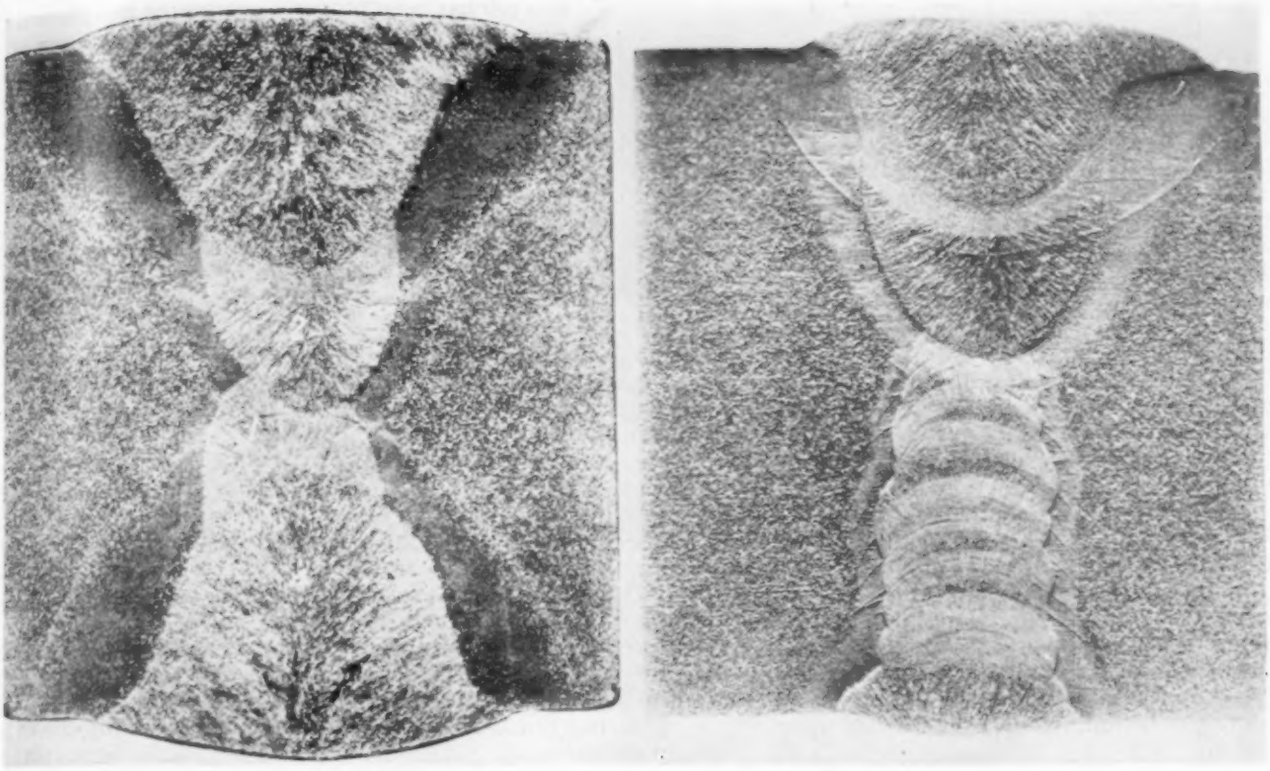
As has been pointed out, no one type of automatic welding process is the perfect answer for all classes of work, even within the scope of our discussion, which is confined to heavy plate fabrication. For that matter, in spite of all the advantages of automatic machine welding in this field, there are still many welding jobs in any plate shop that can obviously be more simply, quickly and economically performed manually. In general relatively long, straight seams, such as the longitudinal and circumferential seams of a pressure vessel, can be more advantageously and satisfactorily made automatically; whereas smaller connections such as built-up fittings, reinforcing plates and analogous work is more desirably hand welded. On the other hand, some built-up fittings, such as manways, can be more satisfactorily automatically welded and Fig. 1 illustrates such a device.

In order to take full advantage of any automatic welding process, a proper welding procedure must be developed. The adaptation of such a procedure is obviously an individual shop problem. The requirements of operation, scope of work, flexibility and machine setup for one shop may well not be applicable to another. What seems to be a nearly perfect procedure for one shop might be inoperable in another location. Nevertheless there are certain fundamental factors which, if thoroughly understood and properly weighed, will simplify the adaptation of the proper procedure control for a given process under its individual operating conditions.

Perhaps at this point it would be well to define what we mean by procedure control. In brief, we consider that procedure control of automatic welding consists of "the development of a complete and coordinated series of operations that will insure a finished product of satisfactory as well as commercially uniform results." Such a definition will bear repeating.

Of necessity, the steps in the development of the procedure as subsequently discussed are those with which we are most familiar and as used in our own plant. Further, while based upon experience gained in five years of automatic welding, and on all of the automatic processes previously described, the actual procedure outlined and

Fig. 2—Shielded Submerged Arc Process. Butt Joint of the Double "U" Type Showing Joint Preparation, Unfused Flux, and Finished Weld



Macrograph-Magnification — 2 Diameters (2¹/₈ In. Plate)

"A"

Automatic Submerged Arc Process Double "V" Butt Weld, 4-Pass.

"B"

Top Half—Automatic Submerged Arc Process — 2 Passes
Bottom Half —Manual Welding — 10 Passes.

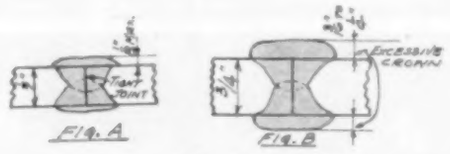
Fig. 3

the welds illustrated are confined to our present preferred method, which is of the completely shielded submerged arc type and as illustrated in Fig. 2. However the statements made with of course certain modifications, would substantially apply to other types of processes.

It should go without saying that it is not our purpose or intention of claiming any special virtue for our particular process or of the procedure control adapted thereto. But we do feel that possibly the results that we consistently obtain in commercial fabrication under our particular conditions might be of interest to others. Figure 3 illustrates a macrograph of typical welds in a 2¹/₈-in.-thick mild steel plate. The weld illustrated on the left is fully automatic, of four passes, two from each side of the plate. The other illustration indicates a two-pass automatic weld at the top half and a ten-pass manual weld on the bottom half. The conspicuously different results obtained by these two methods are clearly shown.

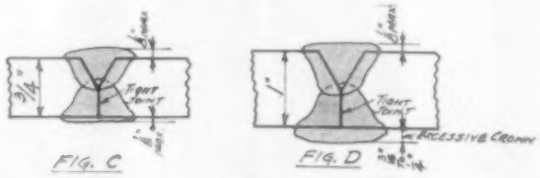
In our definition of procedure we used the phrase "coordinated series of operations." Such coordination is absolutely essential among the various departmental branches of any fabricating shop and they must, both individually and collectively, be not only familiar with and responsible for their particular share of the complete operation, but have at least a superficial knowledge of the various other departments' place in the program. There are, at the minimum, seven separate and distinct steps in the completion of a good automatic weld; usually under the supervision of a different department, namely;

1. Engineering
2. Planning
3. Fabricating
4. Assembly and Fit-up



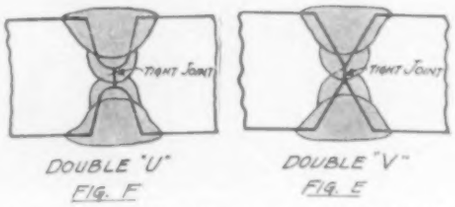
For plate thickness in excess of ¹/₂ in. heat needed for complete fusion will cause excessive reinforcement.

Square Butt (Double Butt Welded)
Adaptable on plates ¹/₂ in. thick or less



For plate thickness in excess of ³/₄ in. heat needed for complete fusion will cause excessive reinforcement on closed side of joint.

Single "V" (Double Butt Welded)
Adaptable on plates ¹/₂ in. to ³/₄ in. thick



Double "V" and "U" (Double Butt Welded 4 Passes)
Adaptable on plates over 1 in. thick

Fig. 4—Typical Plate Joint Preparation Automatic Submerged Arc Process

5. Welding
6. Inspection
7. Maintenance

The duties of each department are almost apparent. But it must be remembered always in automatic welding that the responsibility for its success rests in the engineering and management personnel as well as with the shop fabrication men or the welding machine operators. The engineering drawings must be clear, complete and correct; taking into consideration the customers, code and all other special requirements of each individual job, the welding process to be used and the available facilities and limitations of the shop fabricating equipment. All subsequent planning and operations must be based on the engineering drawings, and if they are not correct or complete, the chances are that the finished job will not be either.

Planning may be a separate department, or preferably a division of the production department. It is their responsibility to see to it that the various operations are assigned to and coordinated in the proper departments in the shop, that suitable equipment and personnel for fabrication are available and that a smooth flow of materials is arranged for. Each job must be followed through to completion so that, in case of emergencies arising that make it desirable or necessary to deviate from the originally planned procedure, an alternate procedure can be immediately determined upon.

If a job has been properly engineered and planned the various shop departments can then devote their entire efforts in seeing to it that the material is correctly fabricated in strict accordance with the drawings and assembled and fit up in a way that will insure the best possible welding. The welding machine operator, thus having assurance that the material has been properly prepared and fit up, may concentrate on the operation of his machine to the exclusion of all other worries, following the procedure previously laid down by the welding supervisor for the nature of the work, the material and thickness of the plate involved and other special considerations. Perhaps more poor welds are due to ill-advised efforts on the part of the automatic welding machine operator to vary his specified procedure in an unsuccessful attempt to compensate for some variable in the fabrication or setup of the work, than to any other one reason.

With the human element as it is, and in spite of all planning and precautions, the possibilities of deviations in materials, workmanship and automatic welding depositions are always present, and there is no positive assurance that even commercial perfection has been reached in the completely welded job unless rigid inspection is adhered to at all times. This inspection should not be confined to the completed job, but followed up during every step of fabrication—from the initial layout to the last finishing operation. Final inspection by the custo-

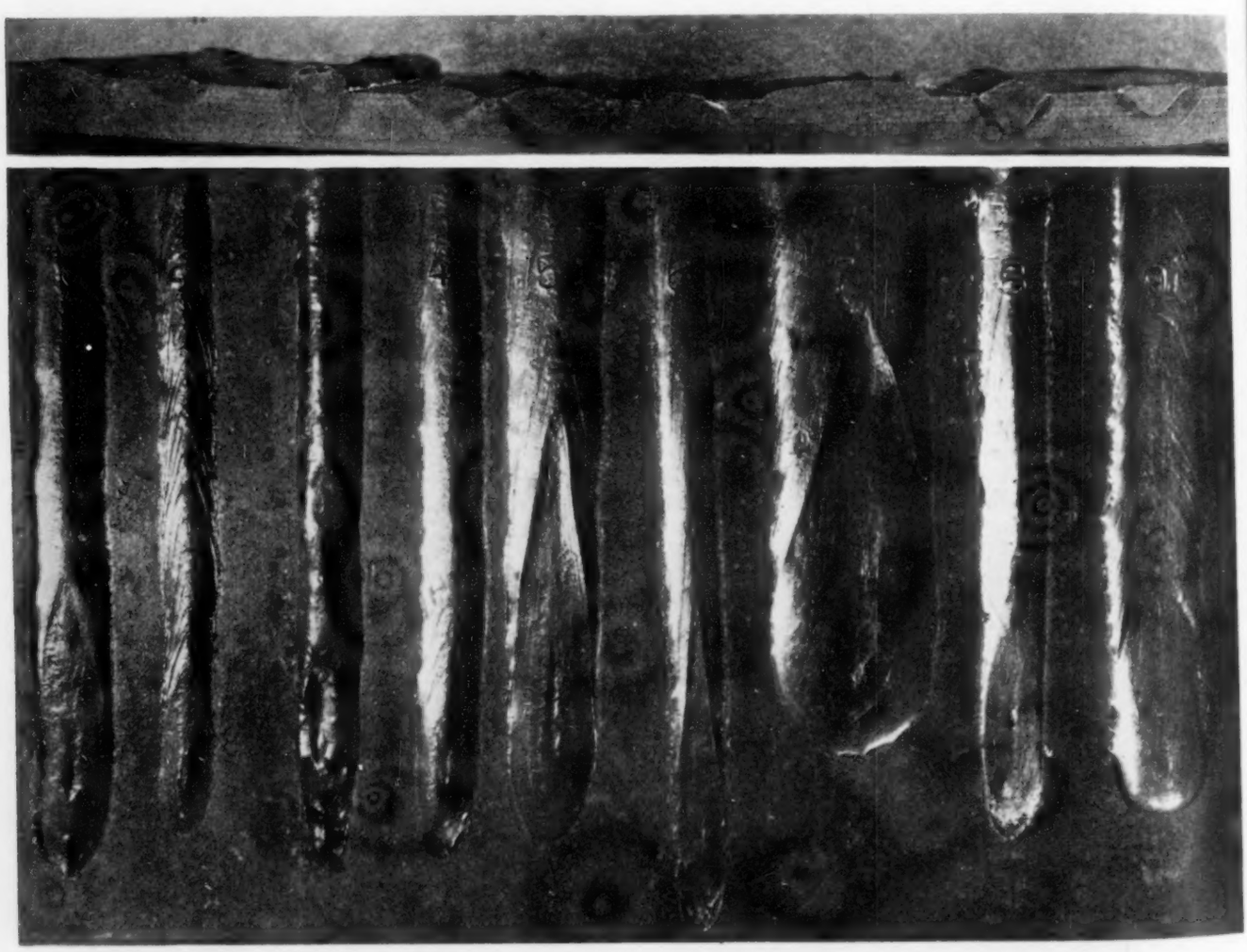


Fig. 5—Variations in Physical Appearance of Welds Due to Changes in Automatic Machine Set-Up (see text)

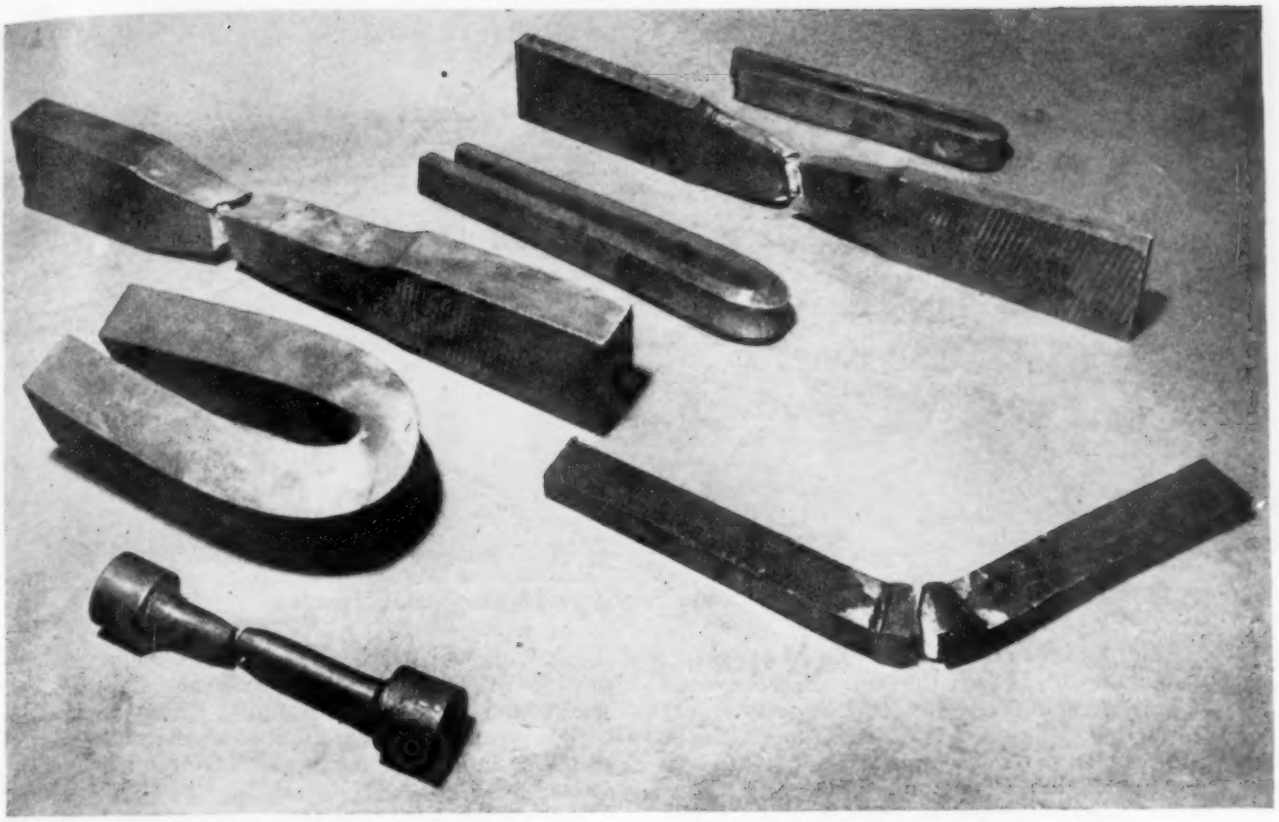


Fig. 6—Typical Physical Test Specimens on Plate Welded by Submerged Arc Process

mer or insurance inspector should only be the confirmation of a job already passed by the fabricator's own inspectors.

Despite correct engineering, proper planning and careful workmanship perfection cannot be approached unless all equipment used both in the preparation for and the welding of the job is maintained in proper operating condition. This is especially important in these busy days when equipment is worked long hours, often with inexperienced help, and repair parts or new equipment are difficult to obtain. The fact that it is easier to maintain equipment in proper operating shape than it is to fix up poor workmanship due to this cause is readily apparent, but is often overlooked.

As far as workmanship is concerned the most important step is plate joint preparation. Since the butt joint is the one for which automatic welding is most used, we shall confine our illustrations to that type. A joint of the highest quality is usually required in heavy plate welding and such a weld must have full penetration, high efficiency, a crown that is neither skimpy nor excessive (usually about $^1/_8$ in. maximum) with easy transition into the base metal without undercutting or overlapping at the toes, be sound and of good physical appearances and with good resistance to impact and fatigue.

Figure 4 illustrates our standard method of plate preparation. For plate thicknesses up to and including $^1/_2$ in. the square butt joint, double butt welded, is used, as shown in *A*. Were this method utilized for plate thicknesses in excess of $^1/_2$ in. the heat needed for complete fusion would cause excessive reinforcement, as illustrated in *B*. The single "V," with double butt welding and as shown in *C*, is adaptable for plate thicknesses of $^1/_2$ to $^3/_4$ in., inclusive. Beyond this thickness the heat needed for complete fusion causes excessive crown on the closed side of the joint, as shown in *D*. For plates 1 in. and over in thickness, either the double "V" in *E* or double "U" of *F* is proper. For plate thicknesses of $1^1/_2$ in. or over a maximum of 4 passes are preferred. Below this thickness 2 passes are satisfactory. For some services the double "U" has the advantage of better penetration due to working on an easy curve rather than on a sharp "V" at the land.

With the methods of plate joint preparation illustrated no backing-up strip is required. In multipass welding the first pass, made with limited penetration, is supported by the "nose" or unbeveled root face of the plate, and this weld in turn serves as a backing for the second weld of deeper penetration made from the opposite side.

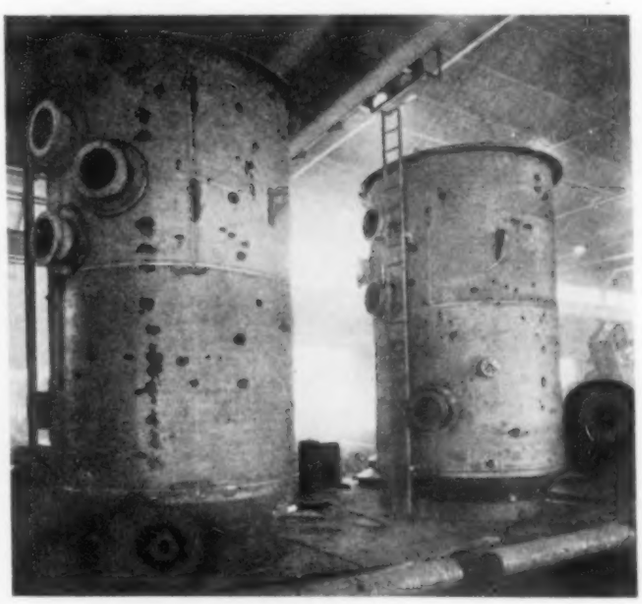


Fig. 7—Bottom Sections of Field Erected Bubble Tower Seams Automatically Welded

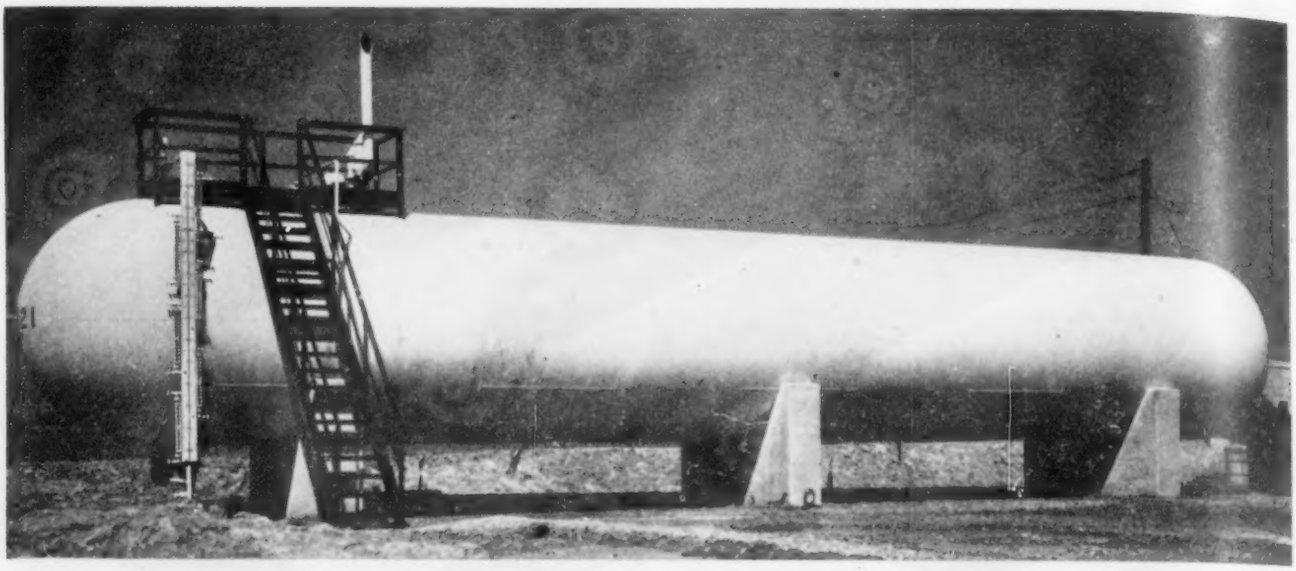


Fig. 8—Pressure Storage Tank with Hemispherical Heads

Hence, it is important that the unbeveled root face be of sufficient thickness to support the first weld, but not so thick as to prevent complete penetration and fusion of the second to the first. This preparation method also eliminates the necessity of back chipping the first weld before application of the second deposit.

The importance of careful and uniform plate beveling cannot be overemphasized. Satisfactory results can be obtained either by machining or burning, providing that modern automatic burning equipment capable of producing scarfing with extremely close tolerances is utilized. But no matter how satisfactorily the scarfing is done, unless the plate edges are carefully fit when rolled or assembled, a uniform kerf is not possible. Raising or lowering the heat when welding in an attempt to compensate for poor scarfing or fitting is seldom, if ever, a satisfactory answer, resulting, as it is bound to do, in lack of uniformity both in penetration and appearance.

It naturally follows that both the setup and operation of the automatic welding machine itself has a vital bearing on the quality and appearance of the deposited weld. The factors most affecting machine operation are the voltage, current input, speed and inclination. Results of variation in these factors on the physical appearance of the weld are illustrated in Fig. 5, which shows, both in plan and cross section, nine different welds made with the same machine under varying operating conditions.

Illustration 1 represents a normal weld made in a flat position, with suitable voltage, amperage and speed. Note that both its appearance and penetration are good. Weld 2 was made under similar conditions, except with high voltage. As can be seen, it has but light penetration and its appearance is only fair. Weld 3 was made under normal conditions, except for voltage, which was low. While its penetration was excellent, its appearance is poor and the crown excessive. Illustration 4 was deposited with all conditions normal except for amperage, which was low. Notice that while its appearance is good, its penetration is poor. Weld 5, made with high amperage but with other conditions normal, indicates a weld that has good appearance and penetration, but poor proportion and excess deposition.

Weld 6, made at high speed but with all other con-

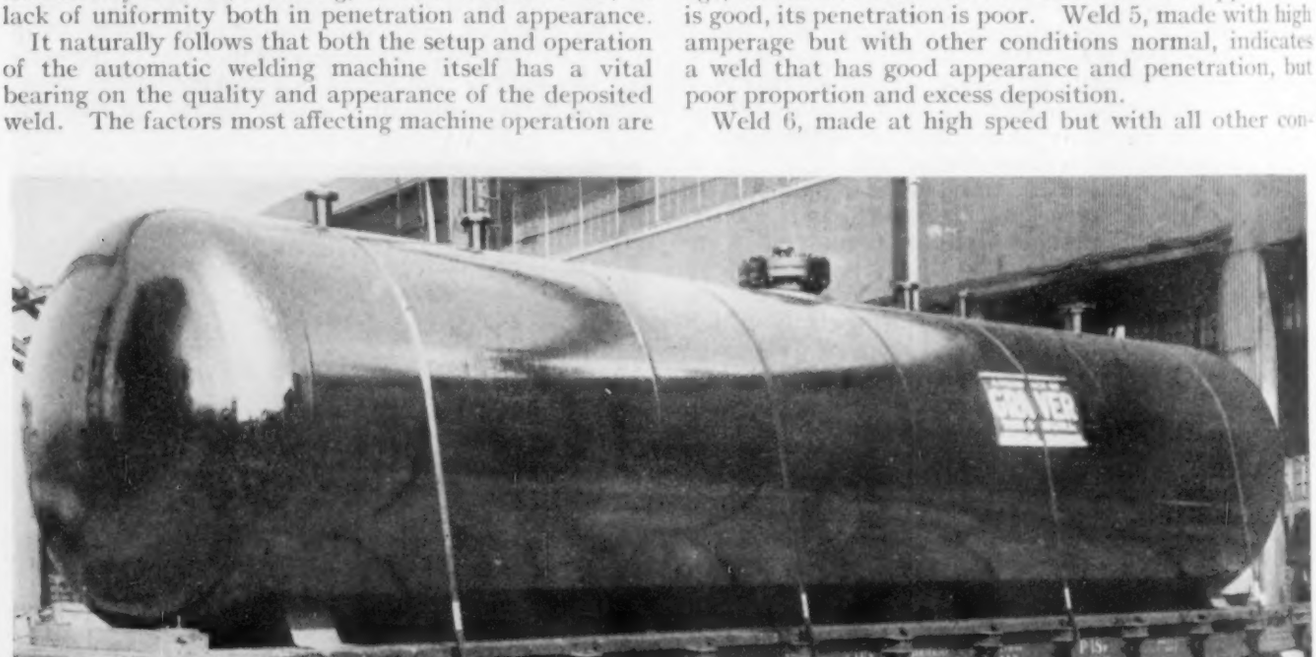


Fig. 9—Typical Automatically Welded Pressure Vessel

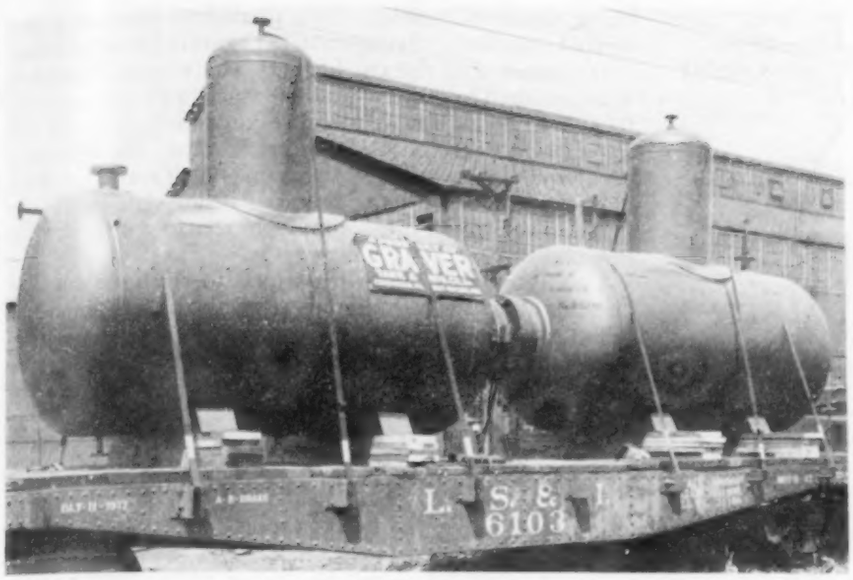


Fig. 10

ditions normal, has good appearance and penetration, but deposit is light. Illustration 7, made at slow speed with other conditions average, indicates excess deposit and poor proportions, although its appearance is good and its penetration fair. The last two welds were made with other conditions satisfactory, but at an incline. With a slight up incline, as shown in Fig. 8, excellent penetration with fair appearance is obtained, but with a slight down incline neither the penetration nor appearance is satisfactory as indicated by Fig. 9.

As with any automatic, and necessarily somewhat intricate piece of equipment, correct operation of the welding machine is dependent in a large measure upon the equipment pertaining to it. The nature of the necessary electrical work demands more than just the average electrician. Operation of the mechanical equipment should be such as to approach perfect precision. However, with a proper appreciation of these requirements and by close application of the procedure steps previously discussed, welds of excellent character may be made.

Typical test specimens are shown in Fig. 6. Both the large and small tensile tests pulled in excess of 61,000 psi. The large bend test shows over 100% elongation in the outer fibres, while both small bend tests show over 50% elongation. Nick bend test indicates sound metal throughout. The 0.505-in. tensile test of all-weld-metal shows approximately 64,500 psi. with 32.5% elongation in 2 in. and yield in excess of 37,300 psi. Figures 7, 8, 9 and 10 show typical vessels in which the excellent physical appearance of automatic welds is apparent.

Conclusions

1. All automatic machine welding processes have certain advantages and disadvantages, and automatic welding itself is not a cure-all for every welding problem, as there are still many services for which manual welding is more desirable.

2. Automatic machine welding, in the fields for which it is applicable, is better, faster and more economical than manual welding.

3. In order to take full advantage of any automatic welding process, a proper welding procedure must be developed, but such procedure is an individual shop problem.

4. While the procedure control will necessarily vary with the type of process adapted and the actual fabrication requirements of a particular shop, certain fundamental factors invariably apply.

5. The responsibility of successful automatic welding rests in the engineering, planning and management personnel as well as with the operating personnel.

6. All departmental responsibilities and activities, from initial engineering to final inspection, must be planned and coordinated; but with sufficient elasticity to permit changes in procedure when actual conditions warrant it.

7. Physical tests on a properly deposited automatic machine weld are better in most respects than of the parent metal.

Starting Inside Cuts on Stacks

By N. L. Lindsay*

A LITTLE trouble is sometimes encountered in stack cutting, in those instances where the design calls for holes to be cut inside the shape. It is common practice to drill a hole about $^5/_8$ in. in diameter in the scrap section of the stack and start the cut on the edge of this drilled hole. In some ways, this is more difficult than starting a cut on the outer edge of the clamped pile, since the small diameter of the hole makes it unhandy to file a vee or run a welding bead down the edge. In addition, if the stack is made up of light plate or sheet material, sufficient preheat to start the cut may warp the top layer or two and prevent the cut from penetrating the stack. A company engaged in making chair seats for military vehicles recently devised a procedure that overcomes all of these difficulties.

Staggered Edge Alignment

These shapes are cut from 10-gage sheet steel, nine pieces to a stack. The design is shown in Fig. 1. Four $^5/_8$-in. starting holes are drilled in the scrap at the locations shown in the sketch. T-handled pins are inserted in two of these holes and the stack is slipped laterally by pushing the pins in the opposite direction from the starting direction of the cut. This staggers the sheets, as shown in Fig. 2, so that the cut can start in the top sheet

* Dominion Oxygen Co. Ltd., Toronto, Ont.

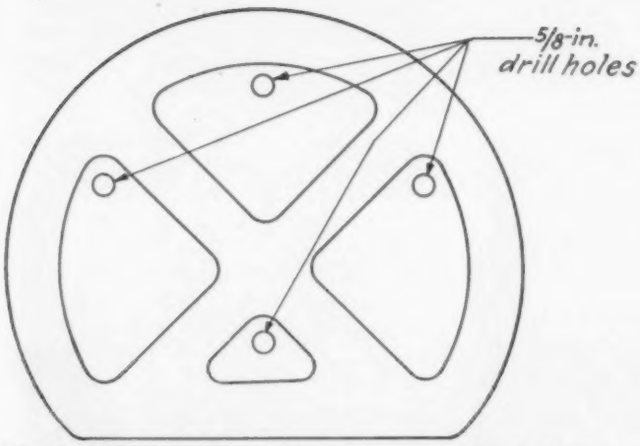


Fig. 1—A Typical Shape to Be Stack Cut Is Sketched Below Starting Holes Should Be Drilled in the Scrap Section

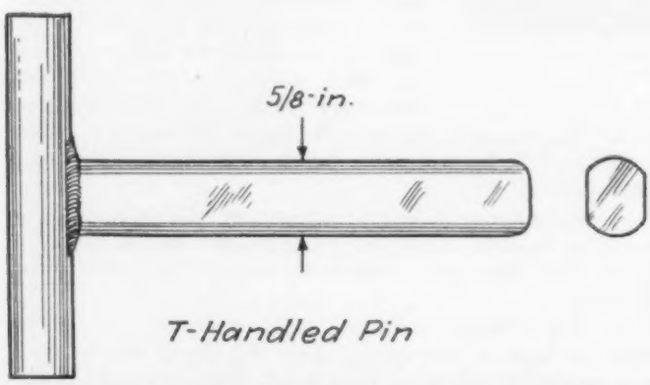


Fig. 2—The Stack Should Be Slipped to Stagger the Sheets, Each Edge Projecting Slightly Over the One Below

first and gradually penetrate through to all the sheets in the stack as the blowpipe advances.

Control of the Preheat

This technique eliminates any warpage of the top sheet. Before the cutting machine motor is turned on, the preheat flames are moved about $^1/_8$ in. onto the work. After a short pause, depending on the thickness of the layers and the size and number of the preheat flames, the nozzle is moved back over the drilled hole, the cutting oxygen is quickly turned on, and at the same time the cutting machine motor is started. This procedure provides a preheated edge for a "flying start" at exactly the point where it is desired that the cut begin. The whole operation is accomplished so quickly that the stack does not have time to absorb enough heat to cause any warpage in the top sheet. Once the cut has been started, the operating technique is practically the same as for cutting solid material. When all the required inside cuts have been made in the stack, it is a simple matter to cut the outside line and complete the shape.

The T-handled pins with which to shift the stack to obtain the staggered alignment of the sheets should be made the same size as the starting holes. They should be ground flat on two sides, as shown in Fig. 3, to provide clearance. This combination of close fit with just enough clearance insures perfectly aligned edges.

Preparation for Stack Cutting

Four preliminary steps should be taken before starting a stack-cutting job: (1) the surfaces should be thoroughly cleaned of all dirt, mill scale, rust and paint; (2) the pieces should be carefully stacked with respect to their edges; (3) they should be securely clamped—tightly enough so that no spaces exist between the layers; and (4) any entrapped air should be released from between the plates by pounding along the line of cut with a machinist's hammer or a mallet. Where a cut can be started at the edge, the sheets may be stacked either in even vertical alignment, or staggered so that each projects slightly over the one below. If these simple rules are observed, no more difficulty will be experienced in stack cutting than in cutting solid material.

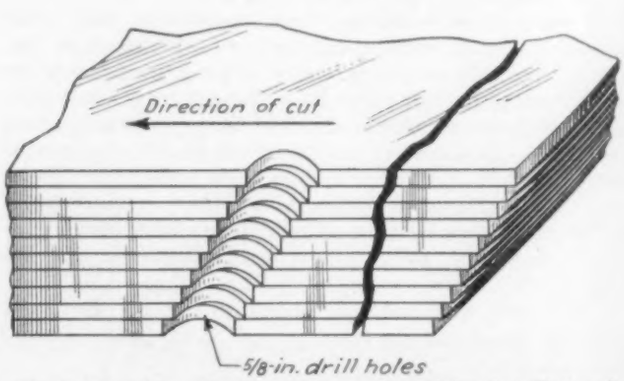


Fig 3—Two Pins, the Same Size as the Holes but Flattened on Two Sides, Are Used to Shift the Sheets

PRACTICAL DESIGN OF
WELDED STEEL STRUCTURES

by H. M. Priest

An up-to-date book of 150 pages copiously illustrated with charts and photos giving practical design information and procedures for the design of welded steel structures. Price $1.00. Bound in cloth covers.

AMERICAN WELDING SOCIETY

33 WEST 39TH STREET NEW YORK 18, N. Y.

Production Planning for Welded Ship Construction with Paper and Plastic*

SINCE the beginning of shipbuilding generally ships have been constructed by the piece-by-piece method. However, due to the urgency of increased ship production, shipbuilding has progressed from piecemeal construction to a production-planned program where the art of building steel ships has entered a new era.

The new design ship which we are now building is designated as the C1-M-AV1. This is a cargo type ship, 326 ft. long, 50-ft. beam, 6240 displacement tons and powered by a Diesel engine.

With the aid of a scale plastic model which has been lofted to exact measurements, all parts of this ship have been care-

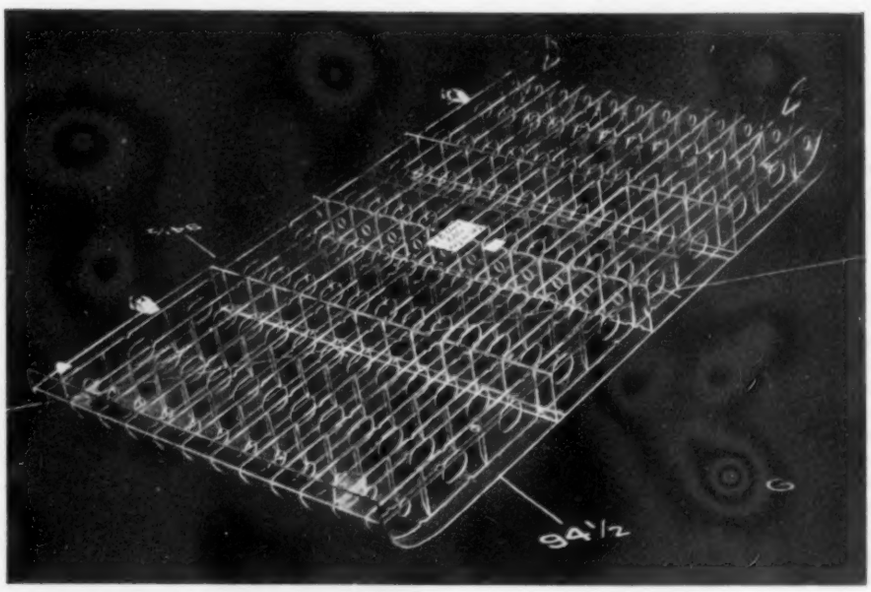


Fig. 1—Inner Bottom Unit Showing Grids, Bottom Shell Plates and Tank Top Plating

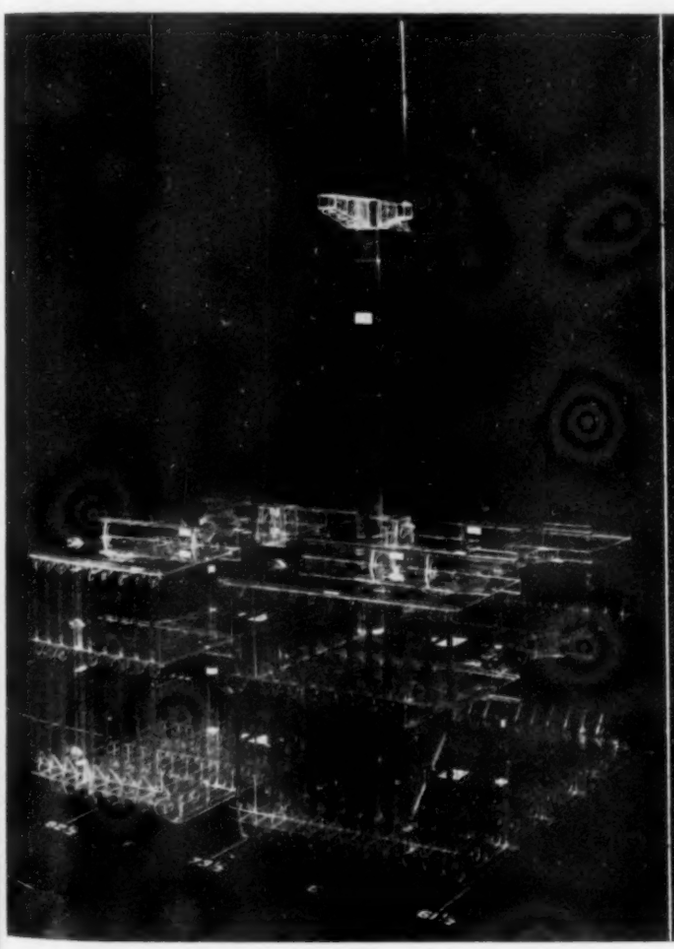


Fig. 2—Two Complete Units in Position Ready to Be Tacked and Welded Together on Ways

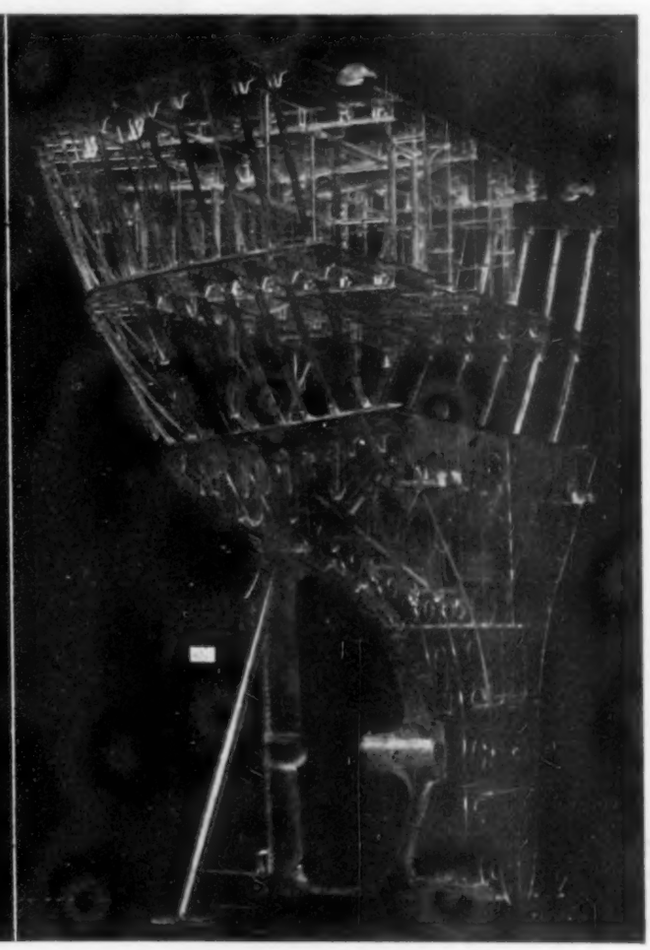


Fig. 3—Aft Peak Section After Being Taken Out of Jig and Ready to Be Transported to Ship on the Ways

* Presented before the November Meeting, Los Angeles Section, A.W.S. Prepared by Messrs. Jack Reid, George Whichelo, Lee Cline, John Rodriquez and E. Garwood, all with the Consolidated Steel Corporation's Los Angeles Shipbuilding Division.

fully planned and an erection program outlined.

This plastic model has 54 unit assemblies which represent the ship structure. Since it is scaled to size and shape, it is studied by all production forces to acquaint them with the planned numerical sequence by which the sections will be erected. The method of erection involves a blending of the three allied operations; namely, erection, fitting and welding. Each unit subassembly or general unit assembly is fitted and welded according to the erection sequence schedule. This type of organized planning eliminates interference of the various crafts; also, material distribution can be carefully checked and approved before actual work has begun on the skids. Subassembly skids are laid out and each erection unit is assigned to a definite location for construction.

Planning of this type also eliminates confusion and the resultant work stoppage before fabrication difficulties are encountered, and only in this manner can the work be organized into a harmonious pattern. With the plastic model as a guide, all welding can be laid out for utmost efficiency for both subassembly units and jigs with the objective in mind to do as much welding as possible in a down-hand position whether it be manual or automatic.

In order to familiarize supervisors with the construction of the ship, classes are conducted by competent instructors to explain the various phases of construction and thus enable each supervisor to know in advance of construction exactly what operation he is to perform. The instructor uses the plastic model in his classes so that each supervisor can visualize what he is to do and how the ship will look upon completion.

With the foregoing advanced knowledge and information in regard to the ship's structure, it has been possible to almost double the amount of automatic welding that has ever before been attempted on this type of ship construction.

To give the reader some insight into the tremendous amount of time and money that is saved by the use of automatic welding, we quote you the following figures which we have obtained from our own experience in automatic welding: The C1-M-AV1 type of ship requires 110,000 ft. of welded joints for the hull structure only. Of this amount of welding 81% of the total hull structure is being welded on our subassembly skids. Of the total hull structure welding, 36% is made by automatic welding. In interpreting these percentages from a production and welding cost standpoint, it means that we can run 7 ft. of automatic butt welding on $^1/_2$-in. plate while only making 1 ft. by manual welding.

In addition, we have also eliminated a great many man-hours in plate edge preparation by using the square-butt joint preparation which requires no beveling or back-chipping which is necessary in manual welded joints. We have also utilized the automatic fillet welder to great advantage thereby speeding up production on structural members requiring fillet welds. Our ratio for automatic fillet welding is 3:1 over manual welding; while our manual operational standard for flat horizontal fillet welding has a ratio of 2:1. (Two feet of flat horizontal fillet welding for the same time it requires to run one foot of overhead horizontal fillet weld.) This means that every foot of overhead welding which we can position automatically cuts operational costs 50% and requires one-half the man power.

Of the 50,000 ft. of manual welding assigned to our skid welding operations, 80% will be done in a flat horizontal position. Economically, this is important from a cost standpoint and also from a production standpoint since it is easier and faster to weld in a flat position than any other position. By placing as much structural work as possible in a flat position the automatic welding process may be employed to good advantage.

Curvature of steel members when made into large sections has also been taken into consideration and even on these sections we are still able to employ the automatic welding process. To accomplish this we have designed and constructed a series of jigs which consist of a male and a female jig for fitting and welding one side and a table-type positioner for welding the opposite side. The fitting jigs are mounted in such a position that they can be rocked from side to side. By operating the jigs in this manner the seams are kept in a flat position. The table-top type of jig is operated on a central axis so as to be positional at any angle.

Since each unit of the scale model is made to the exact size and shape as the final assembly of the actual ship construction, each steel member that will be welded together can be laid out for correct welding sequence. Thus, as near as possible, a stress-free, all-welded ship can be built.

Our sequence for fitting and welding all structural members plays an important part in our welded construction program.

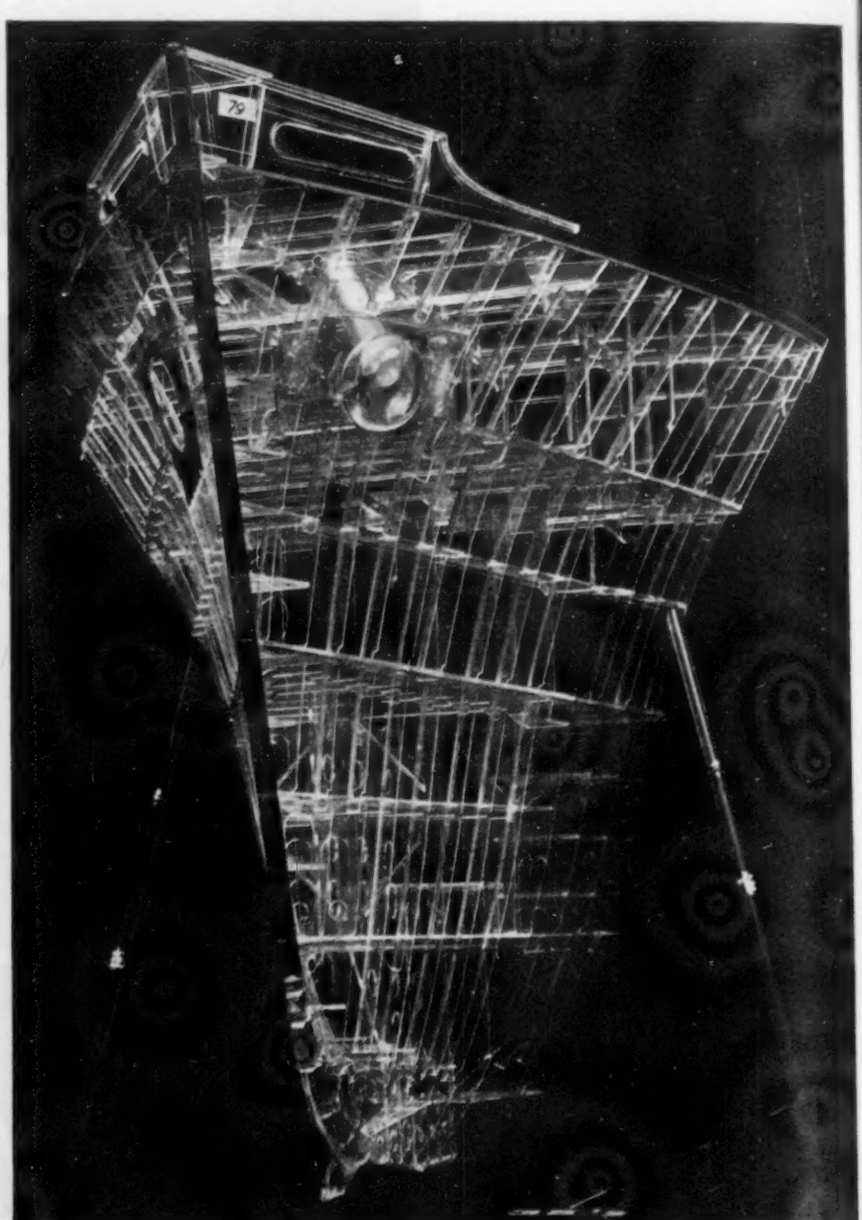


Fig. 4—Front View of Fore Peak After Being Taken Out of the Jig and Ready to Be Fitted and Welded to Ship on the Ways

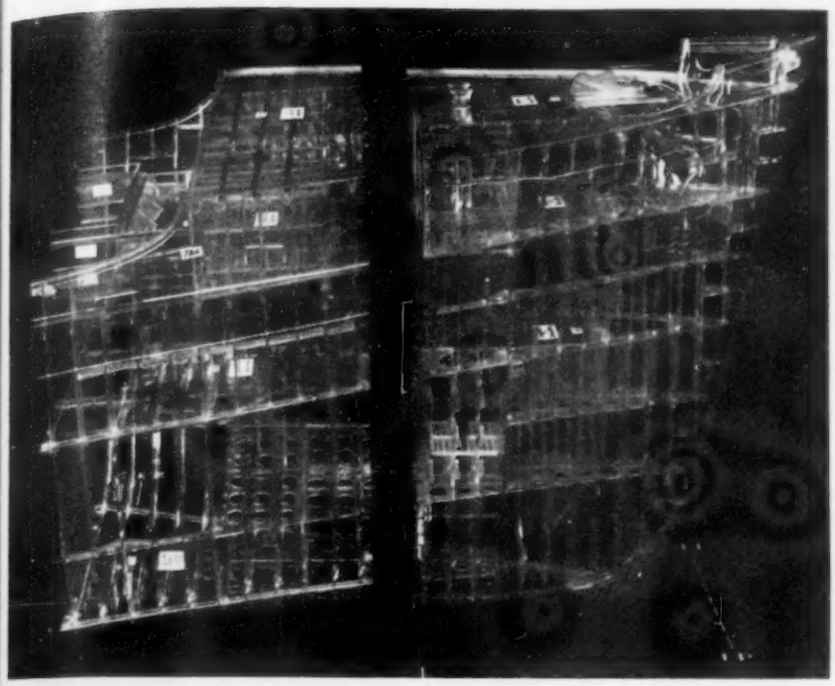


Fig. 5—Side View Showing Fore Peak Section in Position Ready to Be Tacked and Welded to Adjoining Section on Ways

Since one of the greatest difficulties encountered in all-welded ship construction is distortion and residual stress due to welding, there is probably more thought and critical analysis given to welding sequence procedure than any other single operation.

Plans are prepared for fitting and welding each individual unit. We have gone still further by analyzing and breaking down each unit into the total lineal feet of automatic and manual welding required, type of electrode to be used, size of weld, type of joint preparation and number of fitting and welding man-hours required to complete each unit.

In order to illustrate more clearly our operational procedure for erection, fitting and welding we start with the inner bottoms (Fig. 1) which probably have more welding than any other single unit. In order to facilitate welding with a minimum of handling a separate positioner was constructed. This positioner is composed of a flat, table-top jig on which all the floors, girders, intercostals, etc., are fitted. The table is then raised to a vertical position which makes welding possible in a flat horizontal position. While this assembly, or grid as it is called, is being positioned for welding, the tank top plates are being fitted and welded by the automatic weld process on a nearby skid. At the same time these two operations are being fabricated, the bottom shell plates are being fitted and automatic welded in two subassemblies; namely, the *A* and *B* strakes are welded on one skid while the *C* and *D* strakes are welded in a positioner.

After the grid assembly has been completely welded, it is placed on the tank top plating and fitted and welded manually. The unit, now composed of the grid sections welded to the tank top, is turned over and welded to the shell plate assembly. The unit is now completely welded and all welding has been accomplished in a flat horizontal position except on the ends of the *D* strake where the shell plate curves upward to meet the tank top. Using the above operational sequence we are able to weld 95% of the total inner bottom structure in a flat position. The completed unit is now ready to have the piping installed.

While the inner bottoms are being positioned and welded, the side shell is fitted and automatic welded on another skid. The shell plates are laid down in a flat position and after one side has been welded automatically, the main frames, web frames, stringers, etc., are welded to the side shell plating. At this point we use our automatic fillet welder to good advantage by welding the heel side of the frames automatically and the toe side of the frames manually using the intermittent type of manual weld. It is well to note that we do not tack frames to shell on toe side but use a production welder working with fitter who makes the intermittent chain weld at the time the beams are fitted to the shell thus eliminating tacking time.

The unit is then turned over and the outboard side of the side shell is welded automatically. In our welding procedure on this type of welding we begin at the mid-point of the assembly and progress outward working forward and aft, and port and starboard simultaneously. Also, on our 2nd Deck and Main Deck sections we follow the same fitting and welding sequence; namely, laying the deck plates down in a flat position, welding automatically the butts and seams, fitting and welding the deck beams, longitudinal and transverse girders, etc., to the deck plating and using our automatic fillet welder wherever possible.

You will note that in our fitting and welding sequence we are always working out toward the open ends of each individual unit, thereby insuring a minimum amount of distortion and locked-up stress. In other words, our individual welded structures are as stress-free as is possible for any welded structure to be.

After the inner bottoms, side shell, 2nd Deck and Main Decks, (Fig. 2) are completely welded as individual units, they are fitted and manually welded together into one complete unit.

When two such units are completely welded they are ready to be welded together in accordance with the erection se-

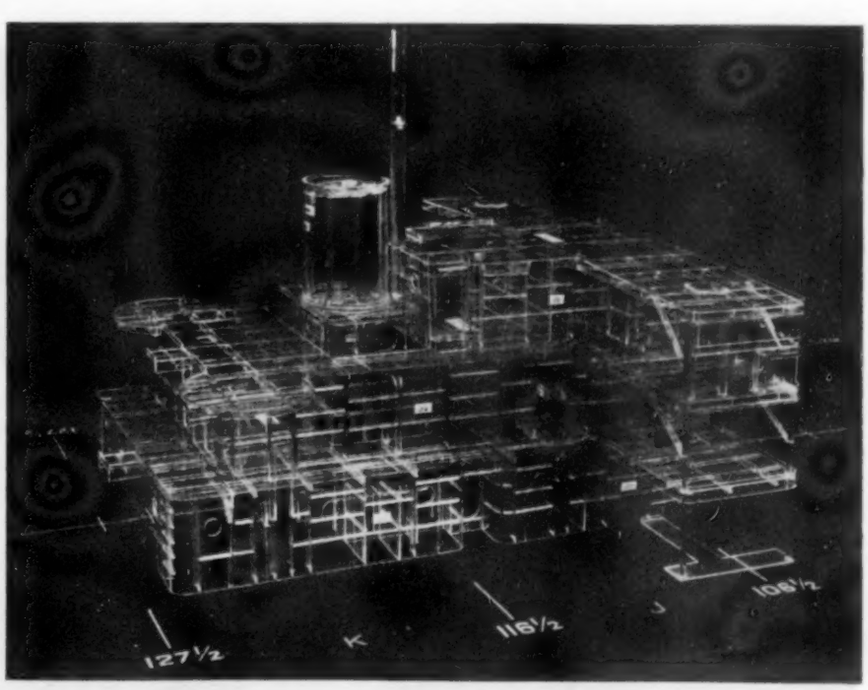


Fig. 6—Superstructure Completely Welded Into One Complete Unit on the Skids and Ready to Be Transported to the Ship on the Ways

quence schedule. Our welding procedure for joining two such large sections is unique in that we tack the two structures together; inner bottoms, side shells, longitudinal girders and decks. We place our welders in such a way that the transverse butts and vertical butts that join the two units together will be manually welded simultaneously and thereby eliminating as much as possible both distortion and residual stress.

The Aft Peak Assembly (Fig. 3) presents an interesting problem and one which we have worked out with success. This particular section is also fabricated in special jigs. The stern frame is set in the jig first. Meanwhile, beams, girders and main frames are welded in a flat position to the underside of the deck plating. When each unit has been welded and is now complete with plating, beams, girders and frames, the units are placed in the stern frame jig in order of their erection. This makes welding on the top side of the plates possible in a flat position. After the frames have been welded to the stern frame, the shell plates are fitted and welded to the stern frame structure in assembly sections. The complete stern frame unit is then taken out of the jig and placed on the ways ready for final welding to the adjoining section of the ship. In this section, also, the two units are tacked together and then production welded throughout the transverse and vertical butts simultaneously.

The Fore Peak Section of this type of vessel (Fig. 4) is also constructed in a jig. The Forecastle Deck, Main Deck, 2nd Deck and stringers are fabricated in a flat position on the skids using the automatic weld process on all plates and the automatic fillet welder on beams in conjunction with manual welding. The beams are welded to the deck while the deck plates are in an inverted, flat position. The frames are then welded to the deck sections and stringer plates and the unit is then turned right side up and transferred to the assembly jig and welded to the stem. The ends of the frames are then welded to the decks which completes the structural welding of the Fore Peak. The shell plate is then fitted to the frames the same as in the Aft Peak and the unit is then ready for way erection.

Figure 5 shows the Fore Peak Section ready to be welded together to the adjoining section of the ship on the ways. These two sections are completely tacked to each other—flat keel, stringers, 11 ft. 0 in. flat, 2nd Deck, Main Deck and Forecastle Deck.

Welders are again placed in such a position that the transverse and vertical butts joining these two sections are welded together simultaneously, thus reducing to a minimum stress and distortion due to expansion and contraction of the steel structures. (Note: Using this procedure all welds are shrinking in the same direction, thus, minimizing welding stress.)

Economy in man-hours and production costs has been inculcated in fabrication of the superstructure (Fig. 6). The side sections are laid out in a flat position and automatic welded using square butt joint preparation. The radius corners of the side structure are the only members that are welded manually. The plating of the various decks is welded automatically on the skids. As on our previous deck assemblies the deck beams, girders, etc., are welded to the plates using both the automatic fillet welder and manual welds. When the deck sections have been completely welded, the superstructure side sections are then placed on the deck and welded to the deck in a flat horizontal position. Each superstructure deck follows the same procedure until the whole superstructure unit is complete. The whole structure, as shown in Fig. 6 is then raised by two gantry cranes and lowered in place on the Main Deck of the ship on the ways. The final welding is made between the superstructure deck and the Main Deck.

The ship on the ways (Fig. 7) now has been completely welded even to the masts and spars and is ready for launching.

In describing the model and the actual fabrication of the steel structure on the skids and ways, it is well to note that each unit has been fitted and welded together separately and then put into final assemblies and welded before it is welded into the final ship structure.

By efficient organization and planning of the various assemblies, each individual section has been fitted and welded in such a manner that when the welding was completed the structure had an infinitesimal amount of stress and distortion.

Scheduled erection is the power house for ship construction and is essential in keeping erection, fitting and welding procedures under constant control. Only when welded structures are erected and fitted to a proper sequence for welding can weld failures be checked.

Construction of a plastic model prior to actual ship construction on the skids and ways conserves the use of critical material and man power and enhances their value from both the standpoint of economy and safety in that specialized crews and techniques can be developed and valuable space can be better utilized. More important still a definite basis of ship construction is evolved and production of completed ships is increased and the resultant is the delivery of ships ahead of schedule.

If the effort of the Consolidated Steel Corporation has proved anything in this war's shipbuilding program, it has demonstrated the ingenuity of our designers, engineers and production men in making steel ships by the way of unit assemblies to form the very backbone of production.

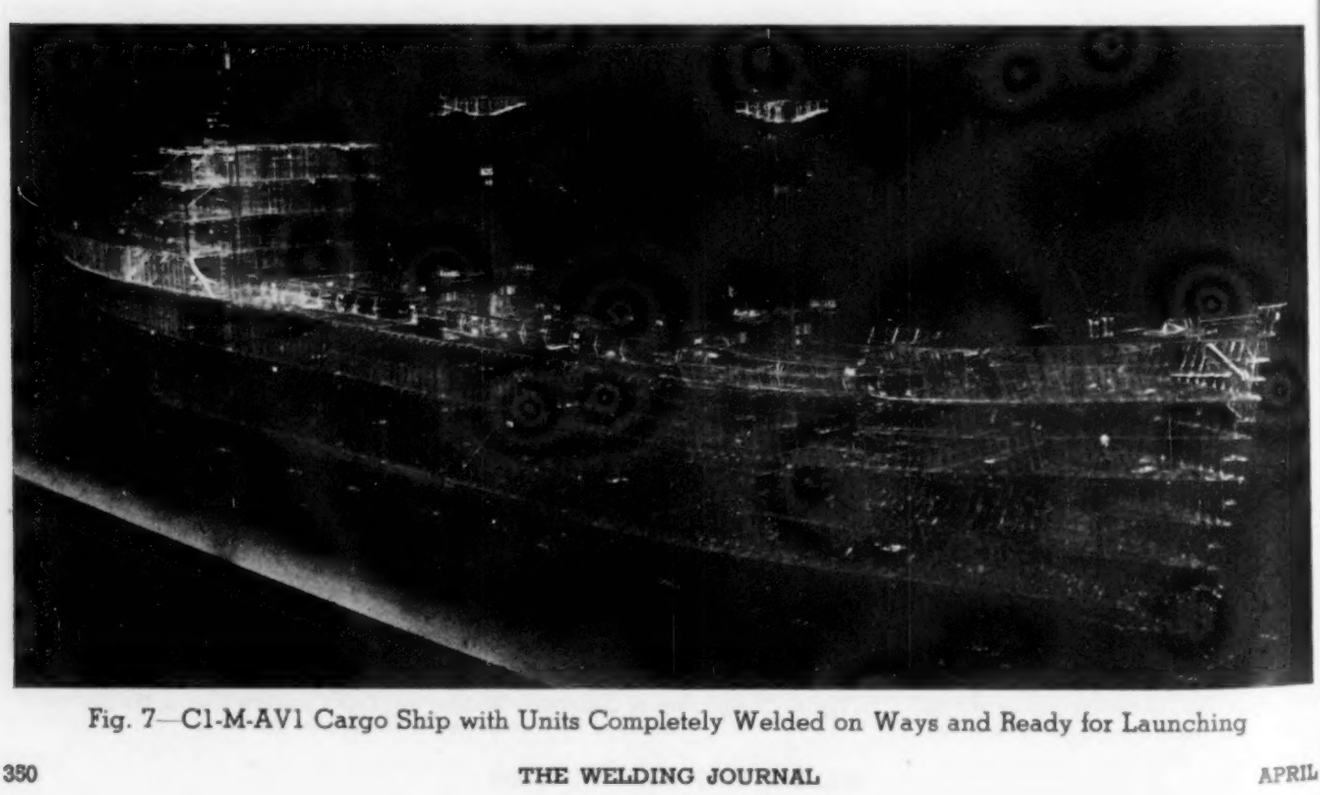


Fig. 7—C1-M-AV1 Cargo Ship with Units Completely Welded on Ways and Ready for Launching

Organized Fitting and Welding in Shipbuilding*

By Milton Forman†

IN the past, there existed a marked tendency in the construction of all-welded ships to deal with welding problems and welding technique as though they were problems of the Welding Department alone. Therefore, when welding procedures and sequences were developed, they usually remained the exclusive property of the welders and the Welding Department.

As experience accumulated, it became more evident that good shipbuilding practice must include as a prerequisite, complete and thorough knowledge of welding, welding design and good welding practices. In the building of all-welded ships, the intimate knowledge of these welding principles is the cornerstone for good shipbuilding practice. The Ingalls Shipbuilding Corp., built on the prospective of building all-welded ships, is absorbing this concept from a fundamental point of view. For as Mr. R. I. Ingalls Sr. so aptly put it, "we must build all-welded ships in the postwar period which are stronger, better, faster and cheaper." And it is only by fully understanding and utilizing the advantages of welding that this can be done.

Fitting and Welding

It has been truthfully stated that a ship cannot be welded either properly or in sequence, if the fitting is not done both properly and in sequence. This is a problem which must be resolved in the building of better all-welded ships.

Planning

In many yards it is also quite evident that very fine planning exists in the top offices, and it is also just as evident that this planning is not felt in the work of the Leaderman and the crews. This is another problem which must be resolved in order to decrease cost and increase efficiency.

Planning vs. Work as Usual

It has also happened that when a sequence is developed and presented, some supposedly "production"-minded people raise the hue and cry "the sequence holds up our production"; "the sequence increases cost." These confusing cries are raised only by those who see a sequence as something foisted upon them from the outside and then, that its execution will be policed by an outside agency. To them, it is a burden, just as a tool is a burden to a man who does not know how to use it. They prefer haphazard work to planning and organization. These same people will claim that it is impossible to plan because there is a shortage of labor. Yet when labor is scarce, it is planning which is most necessary if production quotas are to be fulfilled. Conversely, when labor is plentiful, organization and planning are the prerequisite to prevent wasting valuable labor.

Development of Sequence

It is with these problems in mind that we developed our fitting and welding sequence.

We first made a study of the planned flow of materials and the erection sequence; and coordinated the Fitting and Welding Sequence so that it naturally flowed from the above, for a sequence can be followed only if it becomes an integral part of the planning and construction of the vessel. It must never become a burden for the Supervisor. It must not depend upon policing for its success. It must be executed through planning and should actually facilitate the organization of the work. In such a manner it coordinates the fitting and welding, and becomes the instrument for increasing efficiency and decreasing cost.

Next, we broke down and analyzed all the main hull structure, listing convenient work units for fitting and welding. The work units were listed in proper order for fitting and welding, using as a basic standard, good welding practice and the need of keeping the shrinkage stresses to a minimum. The port and starboard sides were naturally to be completed simultaneously and each unit of work was to be completed 100% before progressing to another unit.

Production Problems

Careful consideration was given to the special production problems of the yard and the work was presented to help eliminate these problems. All tanks were to be completed as soon as possible so that the testing could easily be completed in way of launching. Where certain welding had to be done in way of fitting, the welding was *required* to be completed first. In other words, the best practices achieved through experience for completing the ship, were listed in order and shown in black and white on simple isometric drawings.

The sequence for the operations and coordination of the Fitting and Welding Departments, was detailed and concrete. Yet it remained flexible so that special conditions which arose could be met. But they were to be met in an organized way.

In order to guarantee that the best possible welding practices were followed, specific welding procedures were included to meet all possible conditions.

* Presented before Mobile Section of AMERICAN WELDING SOCIETY, Oct. 12, 1944, Pascagoula Section of AMERICAN WELDING SOCIETY, Nov. 28, 1944.

† Welding Engineer, Ingalls Shipbuilding Corp., Pascagoula, Miss.

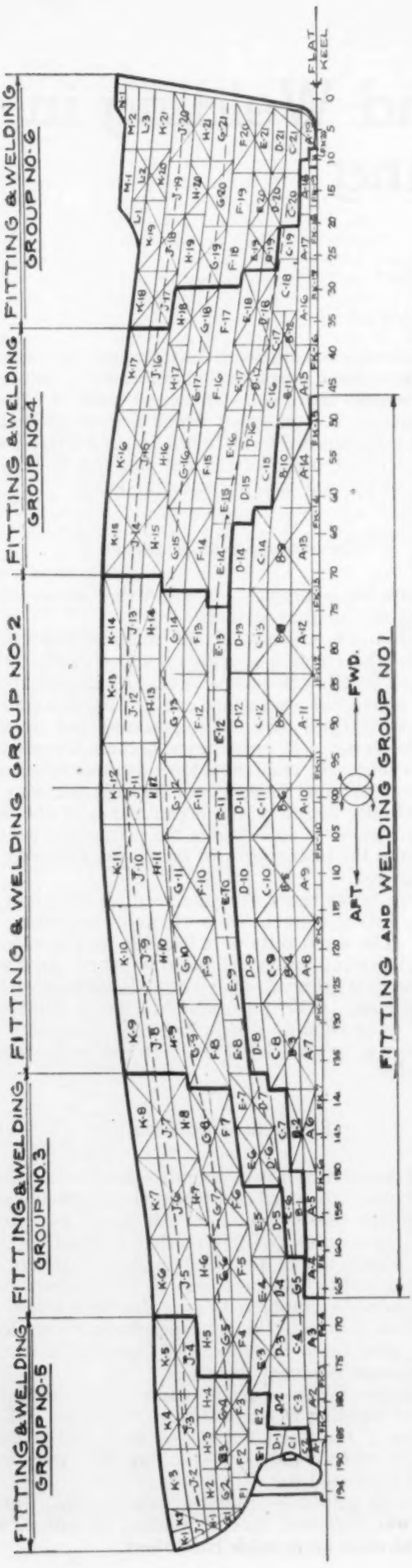


Fig. 1—Shell Expansion Showing Fitting and Welding Groups, Including Breakdown of Footage by Group

Isometric Drawings

We developed isometric drawings to cover the ship in the following manner:

1. The shell was treated separately and divided into six fitting and welding units.
2. The ship's structure was reduced to eight sections represented by two drawings each; one from the flat keel to the second deck and the other from the second to the shelter deck. In addition, each major section of structure, decks, foundations, framing, etc., was detailed in special drawings.

Wherever special joint preparation was required, they were shown in detail on the drawings.

Weld Sizes

Also, in order to facilitate the marking of weld sizes, full information of weld sizes was included on all the main structure. In the process of analyzing the weld sizes, we were able to reduce thousands of feet of welding and eliminate thousands more. The standard for this reduction was to, at least, maintain the minimum strength required but to eliminate and reduce welding wherever possible. We achieved considerable decreases in weld sizes at such welding as frames to shell, collars, brow plates, cargo battens, miscellaneous bulkeads, etc. This not only saved considerable money but decreased distortion, especially in lighter plating. One of the most valuable savings in welding was that much of it was eliminated in inaccessible places. In some cases, a change of joint design did the trick.

Footage

With the breakdown of the units of work as already indicated, it naturally followed that the footage for each unit could be easily computed with size and position listed. This breakdown of footage not only facilitates the disposition of men to jobs, but can be invaluable for the Cost Department in the setting of incentive rates.

Sequence in Practice

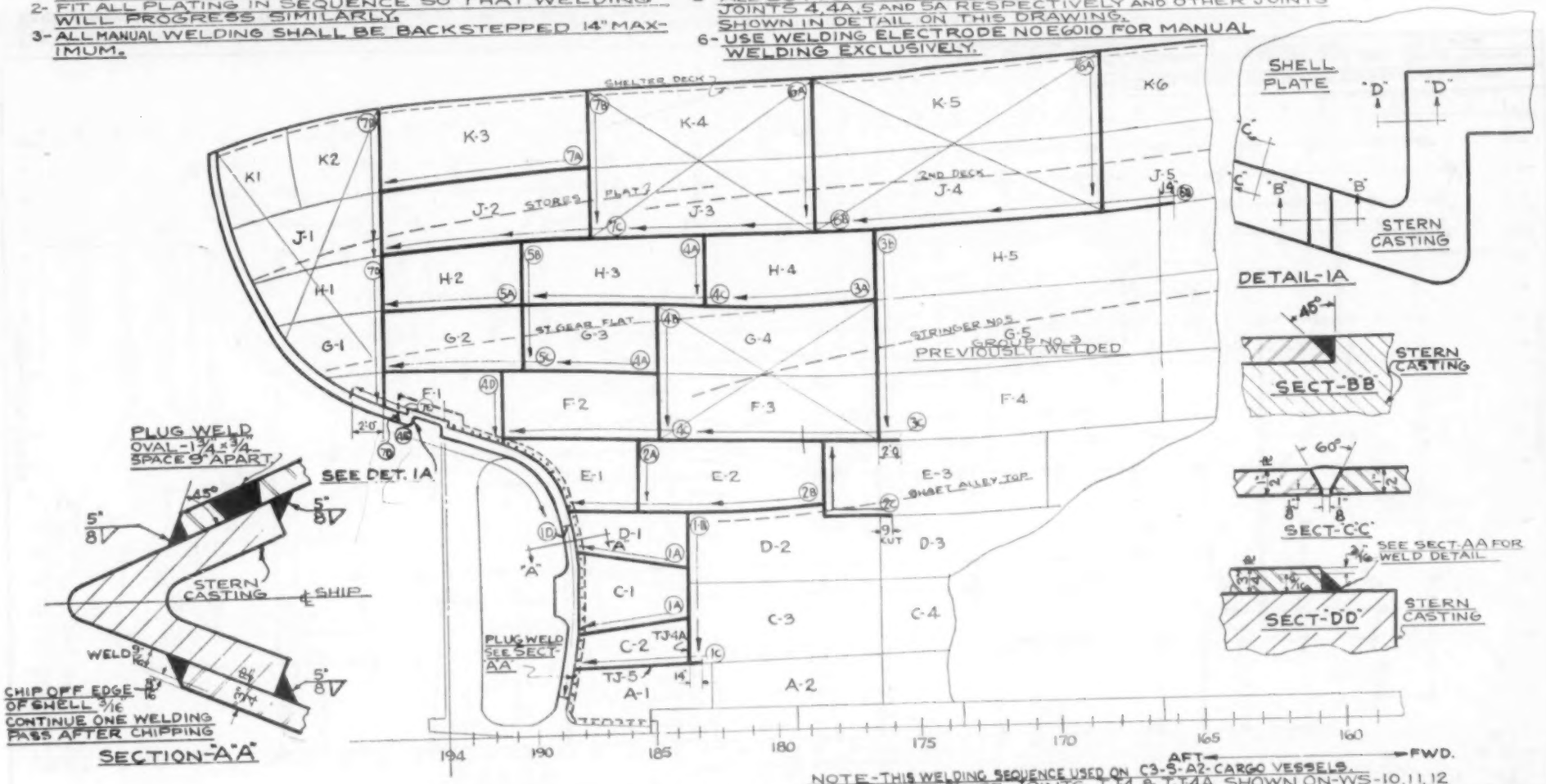
With such a breakdown of the ship, a few simple steps taken by the Production Departments make it a real instrument for increasing efficiency and guaranteeing that the work proceeds in sequence. These steps are:

1. A meeting held once a week with the fitter and welder foremen.
2. Each fitter boat foreman submits a list of what he intends to release for welding. The list is to be drawn up from the production needs of the ship and it conforms to the sequence already laid down.
3. The welder quartermen list what they expect to complete on each ship.
4. Wherever welding or fitting is required in way of future work, the above should be completed.
5. The night welding foreman attend and develop his work orders from the schedule already laid out.

The results of this meeting, therefore, represents the work plan for the week, for fitters and welders.

NOTES

1- ALL FITTING AND WELDING SHALL PROGRESS ON PORT AND STARBOARD SIDES SIMULTANEOUSLY.
2- FIT ALL PLATING IN SEQUENCE SO THAT WELDING WILL PROGRESS SIMILARLY.
3- ALL MANUAL WELDING SHALL BE BACKSTEPPED 14" MAXIMUM.
4- NUMBERS AND LETTERS ENCIRCLED THUS ○ INDICATE SEQUENCE AND DIRECTION OF PROGRESS.
5 ALL BUTTS AND SEAMS SHALL CONFORM TO TYPE JOINTS 4, 4A, 5 AND 5A RESPECTIVELY AND OTHER JOINTS SHOWN IN DETAIL ON THIS DRAWING.
6- USE WELDING ELECTRODE NO E6010 FOR MANUAL WELDING EXCLUSIVELY.



NOTE - THIS WELDING SEQUENCE USED ON C3-S-A2 CARGO VESSELS.
DETAILS OF TYPE JOINTS TJ4 & TJ4A SHOWN ON WS-10, 11, 12

WELDING FOOTAGE IN THIS GROUP-PORT-STBD

TYPE WELD	PLATE THICKNESS	WELDING FOOTAGE
MANUALLY	1/2 TO 1/2	550 FT.
WELDED	3/4 TO 3/4	160 FT.
JOINTS	5/8 TO 5/8	105 FT.
	TOTAL =	815 FT.

DESCRIPTION - FITTING & WELDING SEQUENCE (MANUAL) GROUP NO. 5 - SHELL PLATE

APP'D BY M. Forman — INGALLS SHIPBUILDING CORP, PASCAGOULA, MISS. — DRAWN BY - F. R. HOPKINS.

WELDING ENGR'G. DEPT. — DR. NO. W.S.8

Fig. 2—Detail of Fitting and Welding Group No. 5 Showing Welding Sequence, Welding Joint Details and Footage Breakdown for Various Thicknesses of Plating

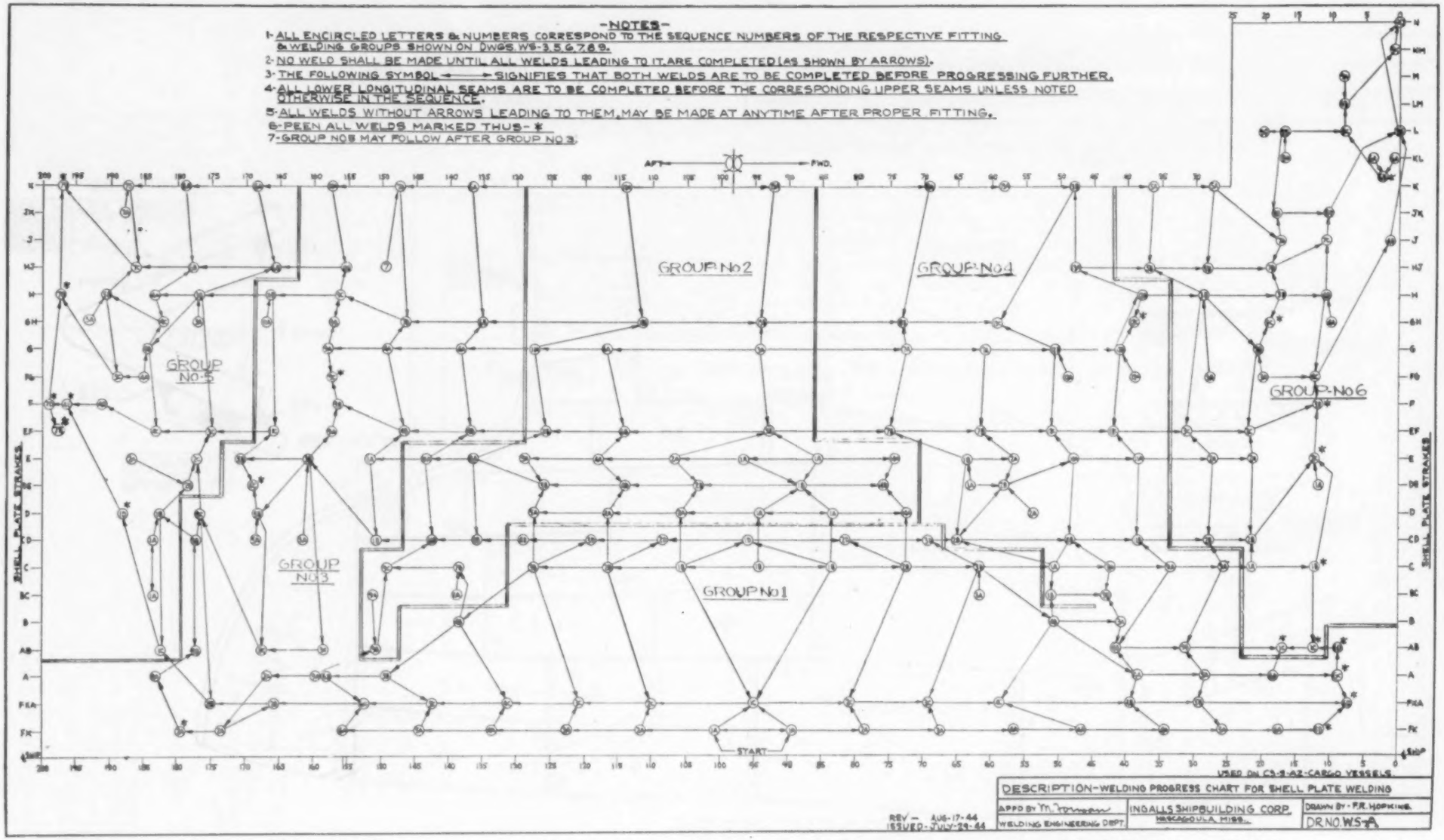

-NOTES-
1-ALL ENCIRCLED LETTERS & NUMBERS CORRESPOND TO THE SEQUENCE NUMBERS OF THE RESPECTIVE FITTING & WELDING GROUPS SHOWN ON DWGS. WS-3,5,6,7,8,9.
2-NO WELD SHALL BE MADE UNTIL ALL WELDS LEADING TO IT ARE COMPLETED (AS SHOWN BY ARROWS).
3-THE FOLLOWING SYMBOL ←——→ SIGNIFIES THAT BOTH WELDS ARE TO BE COMPLETED BEFORE PROGRESSING FURTHER.
4-ALL LOWER LONGITUDINAL SEAMS ARE TO BE COMPLETED BEFORE THE CORRESPONDING UPPER SEAMS UNLESS NOTED OTHERWISE IN THE SEQUENCE.
5-ALL WELDS WITHOUT ARROWS LEADING TO THEM, MAY BE MADE AT ANYTIME AFTER PROPER FITTING.
6-PEEN ALL WELDS MARKED THUS- *
7-GROUP NO 8 MAY FOLLOW AFTER GROUP NO 3.
AFT
FWD.
GROUP No 1
GROUP No 2
GROUP No 3
GROUP No 4
GROUP No 5
GROUP No 6
START
SHELL PLATE STRAKES
USED ON C3-S-A2 CARGO VESSELS
DESCRIPTION-WELDING PROGRESS CHART FOR SHELL PLATE WELDING
APPD BY
WELDING ENGINEERING DEPT.
INGALLS SHIPBUILDING CORP.
PASCAGOULA, MISS.
DRAWN BY - F.R. HOPKINS
DR NO. WS-8
REV - AUG-17-44
ISSUED - JULY-29-44

Fig. 3—Progress Chart for Shell Welding Showing Possible Variations of Sequence Developed at Suggestion of L. J. Blackford, Hull Superintendent. Each Encircled Number Represents a Butt or a Seam Which Conforms to Detailed Group Drawing and They Are Charted by Strake and Frame Numbers. As Welding Is Completed the Circle Is to Be Shaded in and Date Placed Above It

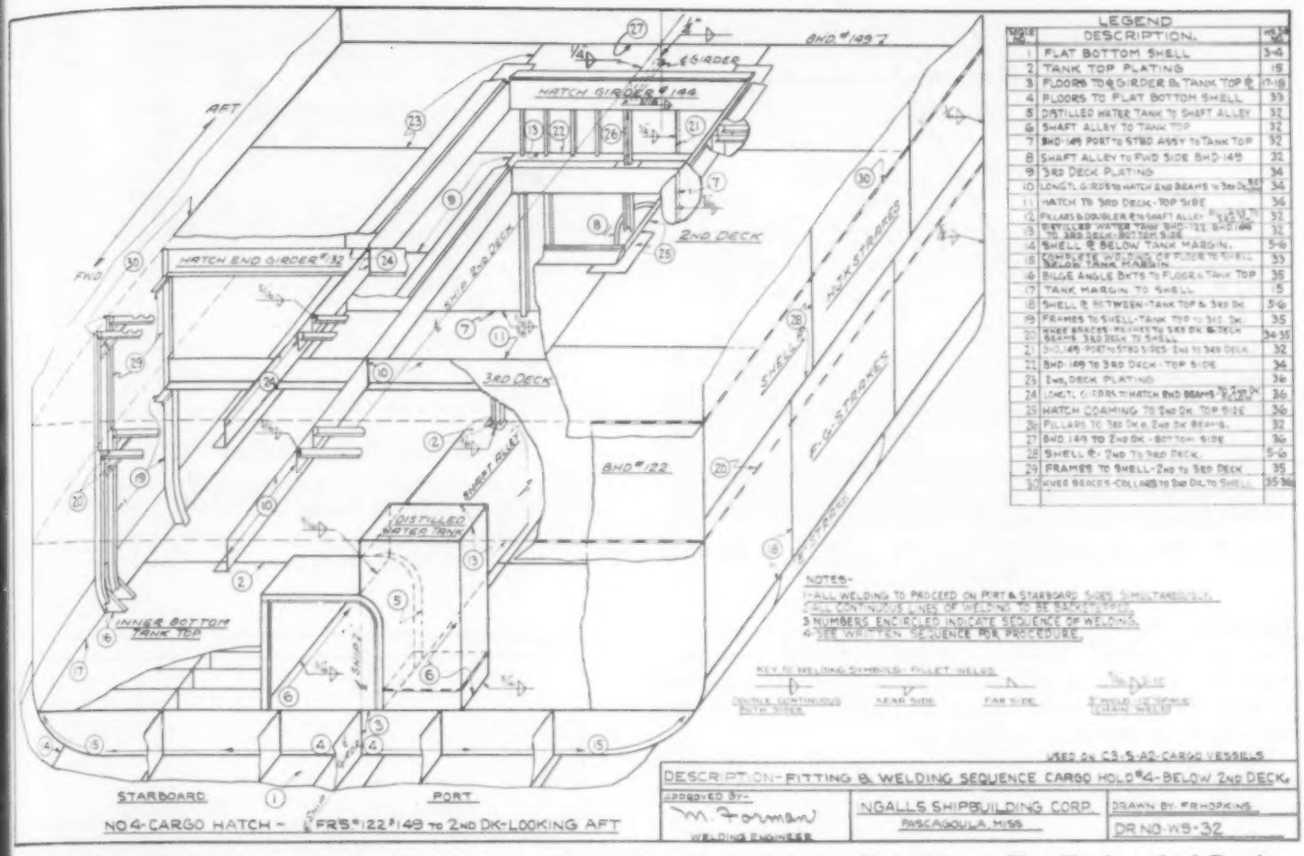

LEGEND
DESCRIPTION.
1 FLAT BOTTOM SHELL
2 TANK TOP PLATING
3 FLOORS TO ℄ GIRDER & TANK TOP
4 FLOORS TO FLAT BOTTOM SHELL
5 DISTILLED WATER TANK TO SHAFT ALLEY
6 SHAFT ALLEY TO TANK TOP
7 BHD 149 PORT to STBD ASSY to TANK TOP
8 SHAFT ALLEY to FWD SIDE BHD 149
9 3RD DECK PLATING
10 LONG'L GIRDERS to HATCH END BEAMS to 3RD DK
11 HATCH to 3RD DECK - TOP SIDE
12 PILLARS & DOUBLER PL'S to SHAFT ALLEY
13 DISTILLED WATER TANK BHD #122, BHD #149 TO 3RD DECK - BOTTOM SIDE
14 SHELL & BELOW TANK MARGIN.
15 COMPLETE WELDING OF FLOOR TO SHELL DISTILLED WATER TANK
16 BILGE ANGLE BKTS to FLOOR & TANK TOP
17 TANK MARGIN TO SHELL
18 SHELL & BETWEEN-TANK TOP & 3RD DK
19 FRAMES TO SHELL-TANK TOP to 3RD DK.
20 KNEE BRACES - FRAMES to 3RD DK & DECK BEAMS, 3RD DECK to SHELL
21 BHD 149 PORT to STBD SIDES 2ND to 3RD DECK
22 BHD 149 TO 3RD DECK - TOP SIDE
23 2ND DECK PLATING
24 LONG'L GIRDERS HATCH END BEAMS to 2ND DK
25 HATCH COAMING TO 2ND DK. TOP SIDE
26 PILLARS TO 3RD DK & 2ND DK BEAMS.
27 BHD 149 TO 2ND DK - BOTTOM SIDE
28 SHELL & - 2ND TO 3RD DECK.
29 FRAMES TO SHELL-2ND to 3RD DECK
30 KNEE BRACES-COLLARS to 2ND DK. to SHELL
NOTES-
1-ALL WELDING TO PROCEED ON PORT & STARBOARD SIDES SIMULTANEOUSLY.
2-ALL CONTINUOUS LINES OF WELDING TO BE SAMPLE WELDED
3 NUMBERS ENCIRCLED INDICATE SEQUENCE OF WELDING.
4-SEE WRITTEN SEQUENCE FOR PROCEDURE.
KEY TO WELDING SYMBOLS - FILLET WELDS
DOUBLE CONTINUOUS BOTH SIDES
NEAR SIDE
FAR SIDE
3" WELD - 12" SPACE - STAGGERED
USED ON C3-S-A2 CARGO VESSELS
DESCRIPTION-FITTING & WELDING SEQUENCE CARGO HOLD #4-BELOW 2ND DECK.
APPROVED BY:-
WELDING ENGINEER
NGALLS SHIPBUILDING CORP.
PASCAGOULA, MISS.
DRAWN BY: F.R.HOPKINS
DR NO. W5-32
AFT
FWD
HATCH GIRDER #144
HATCH END GIRDER #32
2ND DECK
3RD DECK
BHD #122
BHD #149
DISTILLED WATER TANK
INNER BOTTOM TANK TOP
HATCH STRAKES
SHELL
F.C. STRAKES
STARBOARD
PORT
NO 4 CARGO HATCH - FRS #122 #149 TO 2ND DK - LOOKING AFT

Fig. 4—Isometric Drawing Showing Fitting and Welding Sequence for Hold No. 4, Flat Keel to 2nd Deck. Each Number Represents a Homogeneous Work Unit and Is Listed in Legend

Each boat foreman and welding quarterman received a copy of the Fitting and Welding Sequence. A special form can be provided with four columns which would be added to the legend of the units of work. The form to be signed off as work is completed.

Date Released by Fitters	Date Fitting Inspected	Date Welding Completed	Date Welding Inspected and Passed

Note that we are inspecting our fitting *before* welding and are sure that this will not only result in a better job, but also in a decrease in over-all cost.

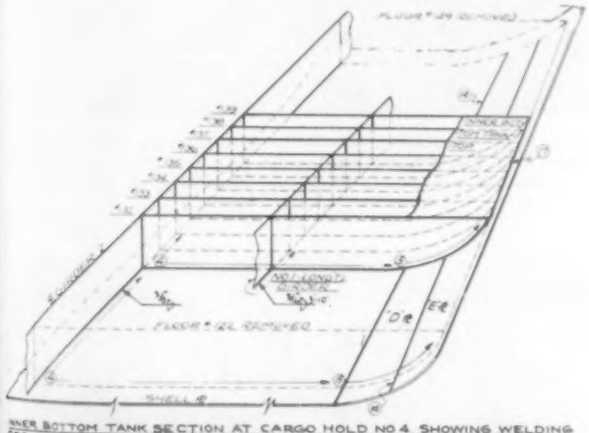

INNER BOTTOM TANK SECTION AT CARGO HOLD NO 4 SHOWING WELDING SEQUENCE OF FLOORS AND GIRDER TO SHELL P. FRAMES #122 TO #149 - PORT SIDE SHOWN LOOKING AFT.
NOTES:
1- ENCIRCLED INDICATE WELDING SEQUENCE SHOWN ON DWG NO - W5-32
2- WELDING TO PROCEED ON PORT & STARBOARD SIDES SIMULTANEOUSLY.
3- DO ALL SIMILAR WELDING IN MACHY SPACE BEFORE PROCEEDING WITH HOLD NO 4
4- BEGIN AT FLOOR #122 & PROCEED AFT TO FLOOR #149.
5- SEE NOTES 1 & 2 ON DWG W5-32 FOR WELDING DETAILS OF FLOORS.

Fig. 5—Detail of Innerbottom Hold No. 4 Showing Sequence. Numbers Encircled Conform to Those in Fig. 4

Sequence Helps Organize Work

In such a way, the sequence must be followed because it is the instrument for organizing the work. It does not have to be policed. Emergencies, shortages of materials, etc., can be met as part of the process of organizing work. They can be foreseen and are no longer emergencies.

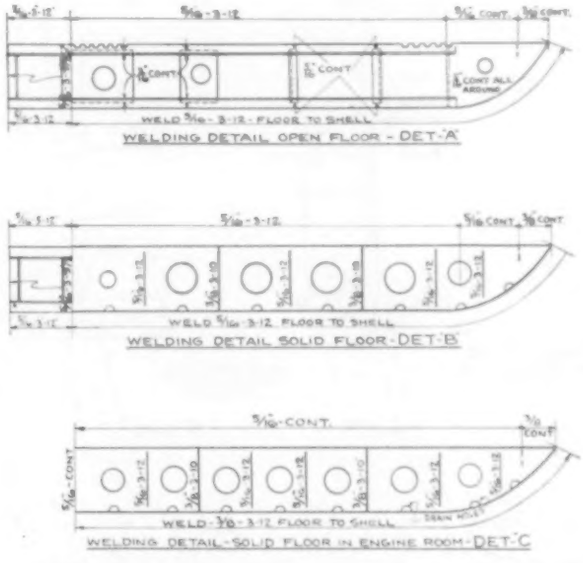

WELDING DETAIL OPEN FLOOR - DET-'A'
WELDING DETAIL SOLID FLOOR - DET-'B'
WELDING DETAIL - SOLID FLOOR IN ENGINE ROOM - DET-'C'
NOTES-
1- 4 DOUBLE CONTINUOUS WELD TO BE USED FOR FLOORS TO SHELL UNDER SUMP TANKS FROM FRAMES #119 TO #131 INCLUSIVE, PORT & STBD & BETWEEN ℄ GIRDER & LONG'TL GIRDER NO 1.
2- WELD 3" ON EACH SIDE OF DRAIN HOLES.

Fig. 6—Innerbottom Floors Showing Welding Details

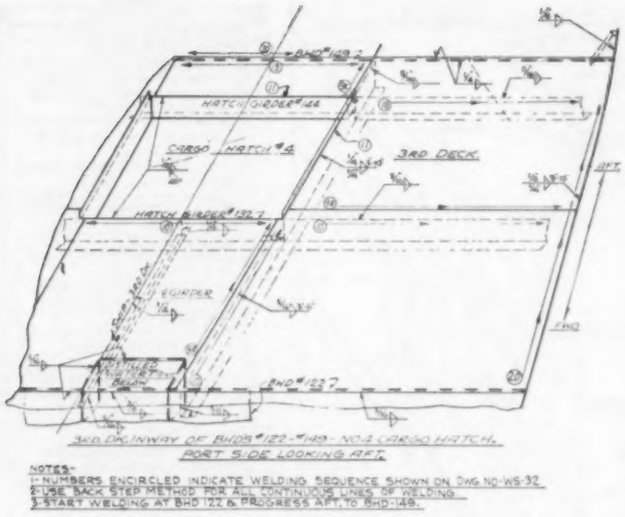

3RD DECK
HATCH GIRDER #4
CARGO HATCH #4
3RD DK. INWAY OF BHDS #122-#149 - NO.4 CARGO HATCH, PORT SIDE LOOKING AFT.
NOTES-
1- NUMBERS ENCIRCLED INDICATE WELDING SEQUENCE SHOWN ON DWG NO WS-32
2- USE BACK STEP METHOD FOR ALL CONTINUOUS LINES OF WELDING
3- START WELDING AT BHD #122 & PROGRESS AFT. TO BHD #149.

Fig. 7—Welding Sequence, 3rd Deck, Hold No. 4 Showing Weld Sizes

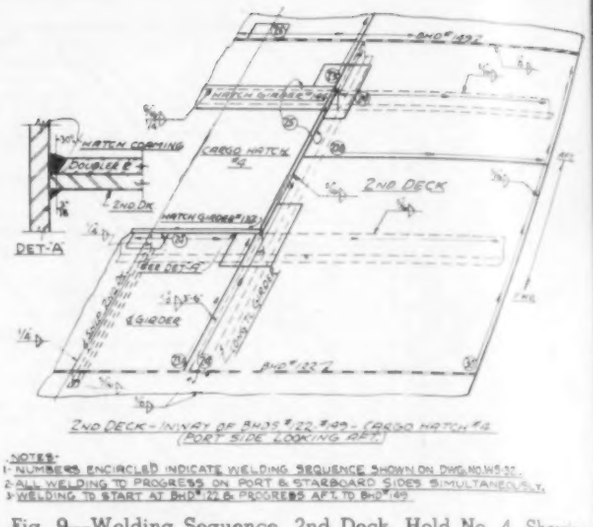

2ND DECK
CARGO HATCH #4
DET-A
2ND DECK - INWAY OF BHDS #122-#149 - CARGO HATCH #4 PORT SIDE LOOKING AFT.
NOTES-
1- NUMBERS ENCIRCLED INDICATE WELDING SEQUENCE SHOWN ON DWG NO WS-32
2- ALL WELDING TO PROGRESS ON PORT & STARBOARD SIDES SIMULTANEOUSLY.
3- WELDING TO START AT BHD #122 & PROGRESS AFT. TO BHD #149

Fig. 9—Welding Sequence, 2nd Deck, Hold No. 4, Showing Weld Sizes and Special Joint Detail

Therefore, the sequence which is concrete and complete, becomes flexible. Where special welding conditions arise, the welding sequence and procedure can be revised to suit the conditions. Such planning can reduce the movement of workers and pickup.

The sequence can obviously be used as an instrument in training new Supervisors and helping them organize their work.

Quality

Although it is true that better organization of work in itself can help quality, a few words should be said relative to improving the quality of our work. Up to now, we have been very proud of the job we are getting, both from the point of view of cost and quality. Yet, if instead of resting on our laurels, we emphasize our shortcomings, analyze their source, we can produce an even finer and cheaper product.

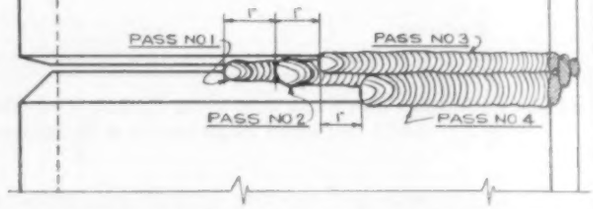


Fig. 10—Method of Stopping Multiple Pass Welds in Order to Insure Good Tie-in

Fig. 11—Type of Local Notch Effects in Burning Which Is Instrumental in Developing Fractures. We Are Placing Great Emphasis in a Drive to Eliminate This Type of Notch Effect

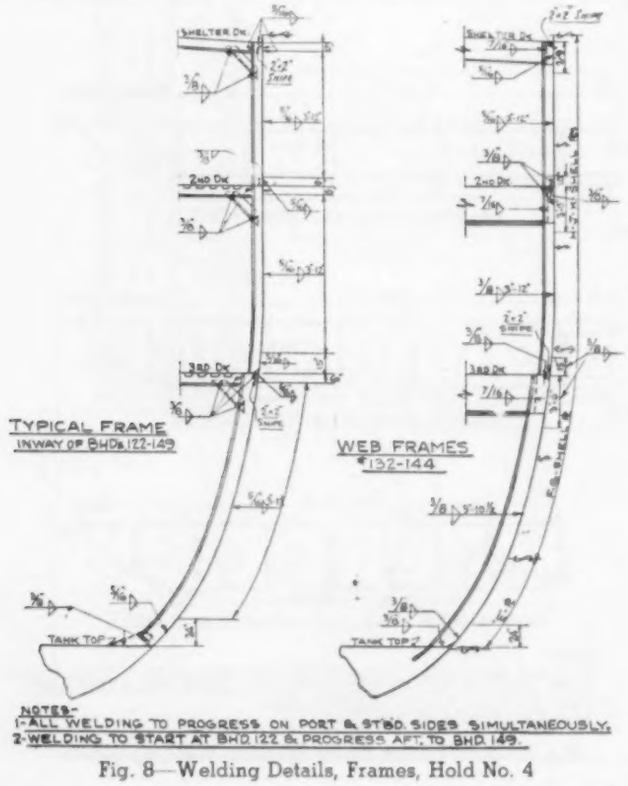

TYPICAL FRAME
INWAY OF BHDS 122-149
WEB FRAMES
#132-144
NOTES-
1-ALL WELDING TO PROGRESS ON PORT & STBD SIDES SIMULTANEOUSLY.
2-WELDING TO START AT BHD 122 & PROGRESS AFT. TO BHD 149.

Fig. 8—Welding Details, Frames, Hold No. 4

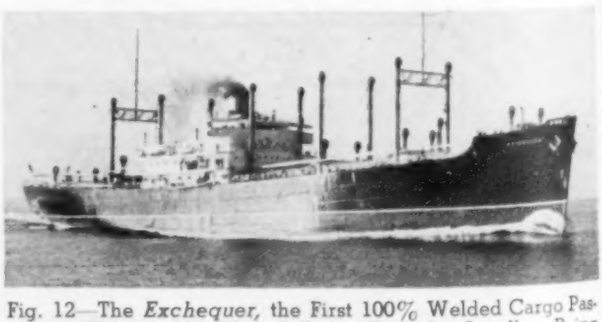


Fig. 12—The *Exchequer*, the First 100% Welded Cargo Passenger Ship in the United States Built by Ingalls. Being Operated by the U. S. Navy as a Seaplane Tender

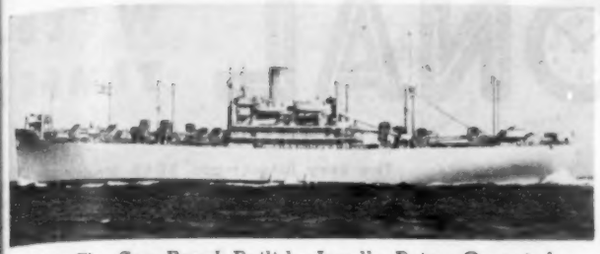


Fig. 13—The *Sea Perch* Built by Ingalls, Being Operated as a Troop Transport. All Ships Built by Ingalls Are 100% Welded

There is an opinion that a conflict exists between cost and quality, that one must be sacrificed for the other. I believe we can safely say that this holds true less in shipbuilding than in almost any other industry.

First, poor quality, both in welding and fitting, always ends with pickup and rework, and the same small saving accrued by doing a slovenly job, is always disproportionate to a job done correctly in the first place without pickup and rework. This is especially true of platen work vs. hull work. In addition to being more costly, the finished job is always inferior.

For these reasons, a concerted drive has been launched:

1. To make our drawings and our templates absolutely accurate.
2. To make our fitting better with special attention to proper edge preparation.
3. To improve the quality of the burning in order to eliminate local notch effects.
4. To further emphasize the deposition of sound welds.

The prevalent opinion concerning the fractures in Liberty ships emphasizes good workmanship as the major problem. The Ingalls Yard has long emphasized this aspect of the work and has obtained excellent results.

Postwar Work

The Ingalls Shipbuilding Corp. is going to build ships in the postwar era, and it is therefore emphasizing that better planning, better organization, better informed workmen will help produce "faster, stronger and cheaper ships."

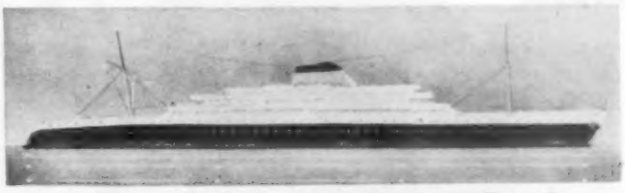


Fig. 14—One of the Postwar Designs for Ocean-Going Luxury Liners. The Type of Ship Which Will Be Plying the Seas in the Postwar Era

Addenda

My sincere thanks to Mr. Frank R. Hopkins, Assistant Welding Engineer, for his aid in the development of the Sequence.

Current Welding Literature

Airplane Manufacture. New Methods Reduce Handwork on Boeing Fortresses, C. W. Easton. Am. Mach., vol. 89, no. 3 (Feb. 1, 1945), pp. 115–120.

Airplane Manufacture. Spot-Welded Parts for P-51s, G. E. Stedman. Welding Engr., vol. 29, no. 12 (Dec. 1944), pp. 44–47.

Airplane Manufacture. Spot-Welding. Aircraft Production, vol. 6, no. 72 (Oct. 1944), pp. 474–478.

Aluminum Alloy Castings. Repair and Salvage of Aluminium Castings by Arc Welding, C. R. Thatcher. Aluminium & Non-Ferrous Rev., vol. 9, no. 7–9 (July–Sept. 1944), pp. 35–36, 38.

Aluminum Alloys. Methods of Joining Aluminum-Alloy Products, E. C. Hartmann, G. O. Hoglund and M. A. Miller. Am. Soc. Mech. Engrs.—Trans., vol. 67, no. 1 (Jan. 1945), pp. 1–21.

Aluminum. Buckling Prevented in Welding Aluminum Sheet. Iron Age, vol. 154, no. 25 (Dec. 21, 1944), pp. 44–45.

Brazing Aluminum Alloys, E. C. Hartmann, G. O. Hoglund and M. A. Miller. Can. Metals & Met. Industries, vol. 7, no. 9 (Sept. 1944), p. 41.

Brazing. Can. Machy., vol. 55, no. 12 (Dec. 1944), pp. 382, 384, 386, 388, 622, 624.

Brazing. Copper Brazing, T. L. Davies. Aircraft Production, vol. 6, no. 69 (July 1944), pp. 346–351.

Brazing. Production-Line Brazing, J. V. Kielb. Welding Engr., vol. 29, no. 12 (Dec. 1944), pp. 35–38.

Brazing. Silver Alloy Brazing, H. R. Lebkicher. Steel, vol. 115, no. 24 (Dec. 11, 1944), pp. 120–122, 124.

Brazing, Silver Alloys. Silver Brazing of Tools and Gauges, F. L. Woodcock. Metallurgia, vol. 31, no. 183 (Jan. 1945), p. 162.

Castings. Studding of Cast Iron, R. Kraus. Industry & Welding, vol. 17, no. 11 (Nov. 1944), pp. 36–39.

Chains, Welding. Stud Link Anchor Chain. Can. Metals & Met. Industries, vol. 7, no. 10 (Oct. 1944), pp. 38–39.

Chromium Molybdenum Nickel Steel. Effect of Overheating on Transformation Characteristics of Nickel-Chromium-Molybdenum Steel, K. Winterton. Iron & Steel Inst.—Paper, Nov. 1944, 7 pp.

Chromium Nickel Steel, Casting. Note on Physical Properties of Austenitic Weld-Metal and Its Structural Transformation on Straining, K. Winterton. Iron & Steel Inst.—Paper, Nov. 1944, 5 pp.

Coal Industry. Min. & Met., vol. 26, no. 458 (Feb. 1945), pp. 117–126. Foreword: Abnormal conditions continue as producers turn out 685 million tons; postwar planning not neglected, A. W. Gauger; Anthracite production best since 1930; mine water big problem, E. Griffith; Underground mine pressure survey studied by ventilation committee, R. Mancha; Preparation plant installations mark time but much postwar planning done, J. Griffen, C. D. Rubert and D. H. Davis.

Cold-Weather Welding, J. S. Wright. Welding Engr., vol. 29, no. 12 (Dec. 1944), p. 39.

Cutting Tools. Arc-Welding Metal-Cutting Tools to Save High-Speed Steel, H. W. Rushmer. Machy. (N. Y.), vol. 51, no. 5 (Jan. 1945), pp. 178–181.

Dies, Welded. Improved Arc-Welded Construction for Steel-Plate Forming Dies, W. E. Klauberg. Machy. (N. Y.), vol. 51, no. 6 (Feb. 1945), pp. 170–172.

Dies. Welding in Construction of Punches and Dies, P. Grodzinski. Mech. World, vol. 116, no. 3023 (Dec. 8, 1944), pp. 647–649.

Electric Welding, Arc, Hazards. Arc Welding Safety Factors, R. F. Wyer. Aero Digest, vol. 47, no. 6 (Dec. 15, 1944), pp. 114–116, 229.

Electric Welding, Arc. Practical Design for Arc Welding, R. E. Kinkead. Hobart Brothers Co., Troy, Ohio, 1943–1944, 108 pp., 100 supp. plates, $3.50.

Electric Welding, Arc. Tool Steel Welding, E. L. Foote. Iron Age, vol. 154, no. 23 (Dec. 7, 1944), pp. 70–74.

Electric Welding, Electrodes. Identification of Constituents of Welding Electrode Coatings, R. C. Vickery. Metallurgia, vol. 31, no. 183 (Jan. 1945), pp. 119–123.

Electric Welding Machines. Energy Storage Welding, H. J. Bichsel. Mill & Factory, vol. 36, no. 1 (Jan. 1945), pp. 94–95, 292, 294.

Electric Welding Machines, Energy Storage. Welding Machines with Condenser Discharge, D. Genkin. Engrs.' Digest (American Edition), vol. 2, no. 2 (Feb. 1945), pp. 77–78.

Electric Welding Machines, Resistance. Heavy Spotwelding, F. Albrecht. Steel, vol. 115, no. 24 (Dec. 11, 1944), pp. 136, 139.

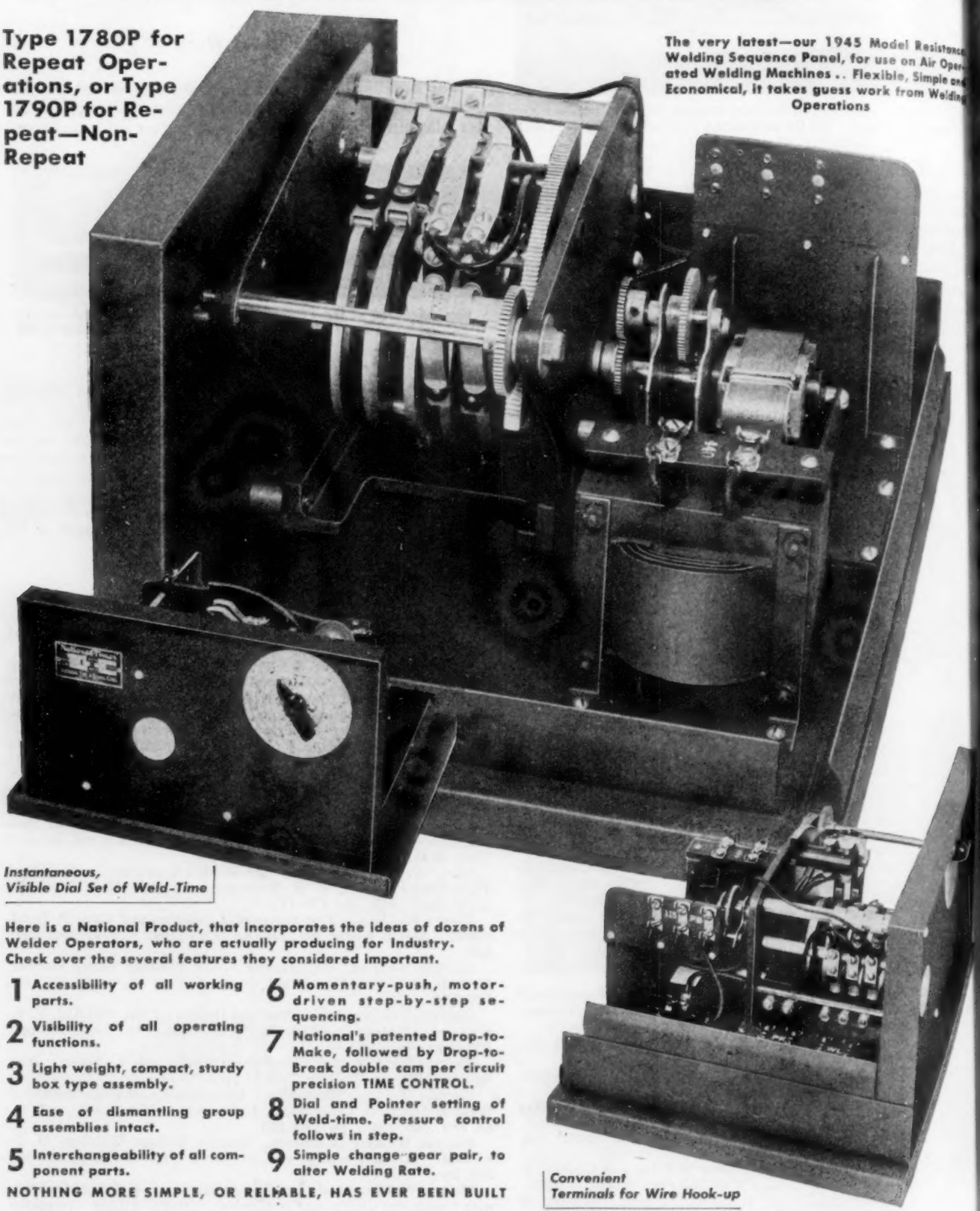
Electric Welding, Power Supply. Reactance and Capacitance, G. W. Stubbings. Elecn., vol. 133, no. 3459 (Sept. 15, 1944), pp. 227–228.

(*Continued on page 377*)

RELY ON RELIABLE NATIONAL WELD-TIMERS

Type 1780P for Repeat Operations, or Type 1790P for Repeat—Non-Repeat

The very latest—our 1945 Model Resistance Welding Sequence Panel, for use on Air Operated Welding Machines .. Flexible, Simple and Economical, it takes guess work from Welding Operations



Instantaneous, Visible Dial Set of Weld-Time

Convenient Terminals for Wire Hook-up

Here is a National Product, that incorporates the ideas of dozens of Welder Operators, who are actually producing for Industry. Check over the several features they considered important.

1. **Accessibility of all working parts.**
2. **Visibility of all operating functions.**
3. **Light weight, compact, sturdy box type assembly.**
4. **Ease of dismantling group assemblies intact.**
5. **Interchangeability of all component parts.**
6. **Momentary-push, motor-driven step-by-step sequencing.**
7. **National's patented Drop-to-Make, followed by Drop-to-Break double cam per circuit precision TIME CONTROL.**
8. **Dial and Pointer setting of Weld-time. Pressure control follows in step.**
9. **Simple change-gear pair, to alter Welding Rate.**

NOTHING MORE SIMPLE, OR RELIABLE, HAS EVER BEEN BUILT

NATIONAL TIME & SIGNAL CORPORATION

600 E. MILWAUKEE AVENUE DETROIT 2, MICHIGAN

The LST—Kingpin of Invasion Fleet

By C. M. Taylor*

BEHIND the successful large-scale invasions made by the Allied Nations lies the skill and production ingenuity of those who build the invasion ships,

*Vice-President, The Lincoln Electric Co., Cleveland, Ohio

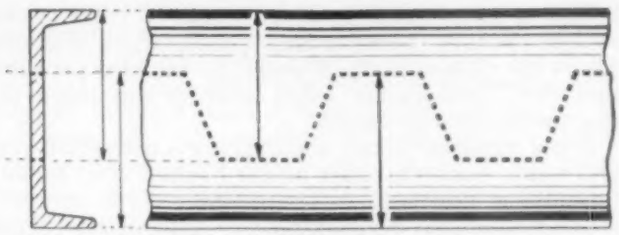
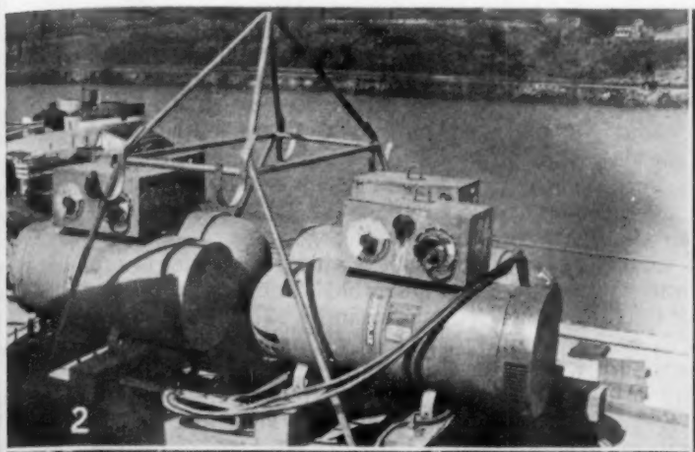
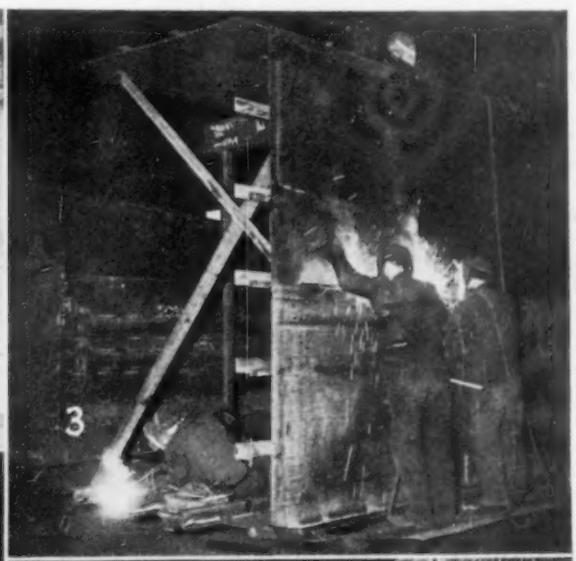


Fig. 1—Detail of Cutting Arrangement Where Two Angles Having Two-Thirds of Effective Depth as Shown by Arrows, Are Obtained from Single Channel





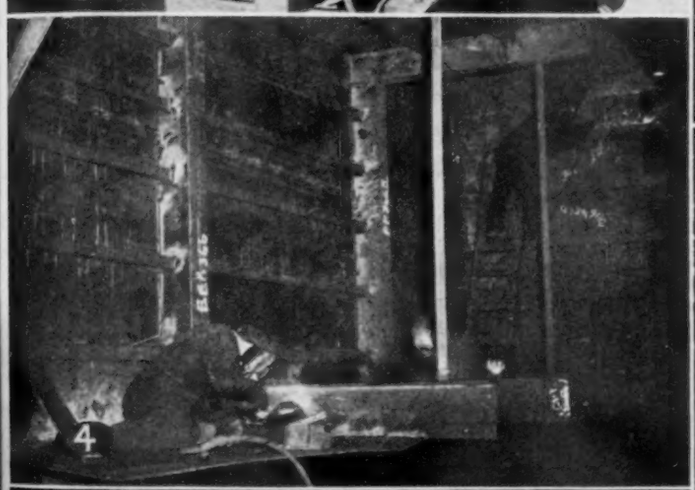


Fig. 2—Generating Units for Welding Power Are Compactly Assembled 4 to a Skid
Fig. 3—Lap and Fillet Welding Operations on a Typical Box Section
Fig. 4—Interior View of LST Box Section of Fabrication
Fig. 5—Close-up of Stern Section Showing Uniformity of Welded Joints
Fig. 6—Clamp-jack Arrangement for Obtaining Good Fit-up of Joints During Welding
Fig. 7—Welding the Gun Guides at the LST Outfitting Dock

a fleet of boats made up of a number of types of craft such as the LST (Landing Ship Tank), largest of the vessels in the class specially designed for carrying personnel, motorized vehicles and other military equipment of a practically endless variety.

Some measure of the unparalleled construction progress made since the start of the landing craft building program is evidenced in production records, release of which has recently been permitted. Although the figures, for security reasons, do not include the 1944 rate, they show that the fifteen types of invasion craft under construction totaled more than 32,000 by the first of this year, with the LST, despite its size, comprising a surprisingly large percentage of the total.

It is interesting to note that without the advantages of modern welding methods this mass production would not have become a reality. However, advancements in welded design and welding technique, combined with the inherent skill of the American shipbuilder, brought about greater ease in assembly, much higher fabricating speeds and more efficient methods which heretofore were thought impossible.

Factors which largely influenced and led up to the current design of the LST included early model small landing barges which were effectively tested in some of the first Commando raids. It then became apparent that fighting equipment and supporting material had to be landed on secluded beachheads without the benefit of harbor or wharf facilities and under adverse enemy action.

Development along this line led to the experiment of cutting a hole in the bow of an existing tanker and inserting a rectangular tube large enough to accommodate a medium tank. A hinged, watertight door was fitted on the forward end of the tube which could be lowered to act as a landing ramp. Further improvements included the designing of a tank deck inside the converted tanker.

From this crude but impressive beginning emerged the LST and other invasion boats which have since played such a large part in turning the tide of war.

It is interesting to note that while the original purpose of the LST was to transport tanks close to invasion beaches, its current design has advanced to the point where it is now used as a freight and personnel carrier, hospital ship, and all-round utility vessel. Long-range cruising and adequate power are supplied by Diesel engines. Big bow doors of unique design permit fast loading and unloading, an exclusive characteristic. These and many other outstanding features incorporated in the LST were built around the freedom of design made possible by the arc-welding process.

Built at a number of inland yards such as those of the Dravo Corporation, located on Neville Island, Pittsburgh, Pa., where the ships are fabricated and fitted, they proceed under their own power down the Ohio River to New Orleans, La., where they cross the ocean to the fighting fronts under the capable supervision of the operating and combat crews.

Using assembly line construction procedures now common in the shipbuilding industry and pioneered by Dravo engineers, the Dravo yards utilize the methods of preassembly of large sections whereby the LST moves ahead as assembly progresses until the ship reaches launching position. The drawing (Fig. 1) illustrates this economical arrangement which is one of the interesting principles carried over from Dravo's extensive barge construction experience.

Power for most of the arc welding is supplied by generating units assembled four in a group on a skid framework such as shown in Fig. 2. This compact setup allows the units to be easily conveyed by crane to various key welding areas.

Prefabrication of the box sections which comprise the main part of the hull is shown in Fig. 3. The plate is slightly flanged at the edge to present a smooth lap joint which offers a minimum of resistance as the ship travels through the water. The two operators at the right in Fig. 3 are joining the plates using $^{3}/_{16}$-in. and $^{1}/_{4}$-in. electrodes, 2 passes.

A close-up of the box section interior showing details of the stiffener members and inside design is illustrated in Fig. 4.

Preassembly of the bottom stern section is affected by inverting the section to permit fast, efficient down-hand welding as shown in Fig. 5.

Excellent fit-up of joints is obtained by means of clamping jacks such as seen in Fig. 6. Lugs to anchor the jacks are first tacked to the plate, the jack is securely

8 9 10

Fig. 8—Finish Welding the Bow Doors After Launching
Fig. 9—Inside Fittings Such as Wash Bowl Supports Shown Here Are Quickly Assembled by the Shielded Arc Method
Fig. 10—Lateral Welding the LST Sides from Suspended Staging

fastened and a large screw bolt is turned down against the plate holding it firmly in position while welding. After finish welding, the jack is removed and the lugs are knocked off with a hammer.

Lateral welding on the ship's sides is efficiently conducted by hanging staging from the ship itself, thus permitting the staging structure to be removed along with the hull as it is transported from berth to berth on hydraulic and manually operated ship transfer carriages. This staging structure with welding operations under way is shown in Fig. 10.

Using the American Bureau of Shipping Rules as a measure of structural strength, the LST is weld fabricated throughout, from its watertight compartments to the thousands of special fittings with which it is equipped. One of the scores of smaller welding jobs, for example, is that of fusing the bow door hinges to the hull.

Other examples of the extensive use of welding, even after the LST is launched, include finish welding of the bow doors (Fig. 8), assembly of inside fittings such as wash bowl support welding as seen in Fig. 9, and fusing the intricate network of tubing (Fig. 7), which forms gun guides for the protection of personnel and superstructure.

The broad knowledge of procedures and efficient practices followed for many years in constructing all-welded barges for inland waterways is said to have been a tremendous help in building up our LST fleet to its present huge proportion.

Chemical and Metallurgical Control in Welding*

By E. C. White†

WHAT is the role required of the chemical and metallurgical laboratory in war production welding? What will be the demands of the reconversion and peacetime production on this division of industry?

Many splendid articles have appeared in the technical publications to date on the functions of the Laboratory in Industry. So much so, that any further embellishments on the topic would appear to be superfluous. However, the past three to four years have seen the same acceleration and multiple expansion of the chemical and metallurgical engineering divisions as, has taken place in the manufacturing divisions. During this period, the normal technical staff in all organizations has been so expanded that the responsible employees of the peacetime organization found themselves as the supervising nucleus around which entirely new chemical and metallurgical departments were built.

Who will dare say that a fine job of "rising to the occasion" has not been done in the large percentage of cases? It is no less a thrilling sight than the lesser ranked men in Service springing to the command in the loss of their superior officer, who has been injured in action.

In this "reforming of ranks," let us call it, in industry, entirely new personnel have been thrown together to work out a required production program, and to do it speedily. This has entailed the rapid adaptation of personalities, the quick appraisal of skills in one's own as well as associated departments.

The reason for this article, then, is to give some pertinent angles for future thought and discussion on the *proper appraisal of various departments' responsibilities* in getting our war job done, and done right, with particular reference to the chemical and metallurgical divisions.

This calls to mind the incident of the ornery judge under whose scrutiny and judgment many unfortunate victims passed, who had come up against the law in various serious occurrences. As the years rolled on, it became apparent that in this court the under dog, let us call him, found little, if any, sympathy from the bench. So much so was this the case, that, in due time the judge was removed from the bench, and in the passing of events in his retiring years, he appeared as a cashier in one of the banks of his home town. An old acquaintance from the former town of his judgeship had occasion to cash a personal check at the ex-judge's wicket. "I'll have to ask you for some identification in order to cash this check" came the query from the cashier. After long fumbling through various wallets and pockets, the customer replied in indignation, "Shucks, Judge, you show much more concern about cashing this check than you did about handing down those stiff sentences to the boys over Kansas way." "Oh, well," said the judge of previous years. "You see, in this case, there is money involved."

So, in a discussion of this type, a keen study is necessary of relative values and the duties of the mechanical engineering and design, chemical and metallurgical engineering, and the manufacturing department, with it many coordinated departments, such as inspection, material supply, etc.

Welding

In the quality control of our enormous welding program, going on in present-day war production, it is particularly apparent to those involved, the necessarily close tie-up between the chemical and metallurgical division, and the welding superintendent and his staff.

The one important fact that comes to the writer's mind is, that in welding, whether fusion, resistance or any other method, there is a tremendous "human element" involved which does not readily lend itself to panel settings, cycle control or predetermined methods of operation.

This is a stimulating angle which challenges equally the welding engineer, production superintendent, control technician and the set-up man. Herein, I feel, lies the intriguing appeal in the present-day assembly of parts by welding, with the consequent tremendous saving in valuable time and expensive equipment.

Interdepartmental Procedure

Let us look, first, at the setting up of a program of Resistance Welding Procedure under our present Army-Navy Specifications. This brings attention, first, to the necessity of a meeting of the minds between the various departments.

The various steps on a new welding contract consist, very briefly, of setting up a program, of:

1. Making necessary blueprints.
2. Getting material on the job.

* Presented at the Oct. 6, 1944, Meeting, Detroit Section, A. W. S.
† Chemical and Metallurgical Dept., Ford Motor Co., Dearborn, Mich.

3. Certifying this material to specifications.
4. Determining the most suitable panel settings to obtain maximum strength of weld.
5. Production in satisfactory volume of assemblies to be inspected and sold to the Government.

You will note No. 3 and No. 4 divisions involve the chemical and metallurgical engineering division. Here it is of absolute necessity that there is a mutual understanding of the interresponsibility of the mechanical engineering, chemical and metallurgical division and the manufacturing engineers.

Requirements of the Chemical and Metallurgical Engineering Division

The chemical and metallurgical laboratory should be staffed by competent men, of broad preliminary training in production as well as chemical and metallurgical control, as only in this way can they appreciate problems of the production superintendent, who, finally, is responsible for making the finished article.

The introduction of Army and Navy Specifications has at one and the same time, stepped up the requirements in our present-day welding procedure, and also put a greater responsibility on the laboratory. No longer is it just a case of "Cut the sample, Jack, and let's have a look at it." The Lab man, or girl, as is often the case today, then cut the sample, gave it a rough polish and handed it back to "Bill" in Production, never more to see it and knowing less of its origin.

The functioning of the chemical and metallurgical engineering department in this manner requires little skill of a technical nature, and is of equally small value to the production superintendent. This would be more of the "errand boy" type of control. Although technically trained men, who are equally familiar with the "Set-up" man's problems and also the superintendent's, are not readily available, it should be the aim of those charged with the responsibility of building up such a department, that men, coming as near as possible to these qualifications, be chosen to supervise welding control laboratories.

Without the respect for the chemical and metallurgical staff, by the production department superintendent, foremen, set-up men and the welders themselves, it is difficult, to see how results, that are definitely constructive, can be accomplished.

Requirement No. 1.—So let us put that fact down as a *first requirement* of such a technical division. It must command the respect and cooperation of production and mechanical engineering by the ability of its staff to assist in getting rapidly into production, and at the same time maintain the rigid military standards.

Confidence of the Army and Navy resident representatives and inspectors in charge, has been gained by the chemical and metallurgical engineering divisions throughout the Country. This confidence has grown over many months of cooperative effort in the maintenance of required standards without unnecessarily hampering production.

As a *second requirement* in the maximum utilization of a technical staff as an aid to production, I would put *speed in obtaining the information required by the production superintendent.* Let us say, for instance, specific panel settings are in the process of development for a required assembly operation. Test strips of the gages and materials in question will be welded by spot, stitch, seam or other method as required, and samples submitted. Completion of the cross section, polishing and etching of this test strip, should be possible within one hour of the welding operation.

This prompt service is of particular value inasmuch as any necessary changes in panel setting, as to percentage of heat, cycles required or pressure, may be made and new samples submitted until a mutually satisfactory macro section is obtained.

This procedure may well be followed in fusion, metallic arc, atomic or acetylene welding, although control of these types of welding presents their characteristic problems. There is a tremendous value to the welder himself, and also to the "set-up" men, in having the opportunity of seeing and studying the "inside" or cross section of their welds. This cooperative angle between departments pays real dividends in increased production, due to a marked decrease in rejects. The welder takes a new interest in his particular operation, and maintains this interest throughout his work, if given frequent opportunities of viewing his workmanship, with equipment not ordinarily available to him.

It is a common fault of the technically trained man, particularly if not too many years have rolled by since graduation, to underestimate the skills of the field or production man. This production or producing man, may not have a particular degree, but in many, many cases, he has an uncanny skill in his welding, which the chemical or metallurgical engineer might well appreciate in arriving at his decisions on any particular welding problem.

Requirement No. 2.—Speedy information on welds should then become *requirement number two,* in order to obtain the utmost in cooperation between the welding production division and the chemical and metallurgical department.

As a *third requirement* of such a technical division, as is under discussion, I would place an *accurate appraisal* of the various methods of inspection of welds, such as, (*a*) visual inspection, (*b*) use of macro sections, (*c*) tensile tests, (*d*) twist tests, (*e*) X-ray of welds and other investigative methods.

Obviously, it would never be possible, in a development of a specification, for a certain gage, to lay down a basis of comparison or requirement by percentage, such as, 30% for a good macro, 30% for a good tensile test or some such percentage for the workmanlike appearance of the finished job.

Constantly, we see welds, the macro sections of which show good nugget area and penetration, but the welds, nevertheless, are brittle; we see brittle welds that have good tensile strength; we see sound appearing welds which have little or no penetration; we see welds with poor penetration which will pull metal, etc., etc.

Here, again, enters the necessity of combining the opinions of the technical and production staff. Possibly a Utopia will never be attained where a unanimous opinion is reached by all divisions, on every weld, examined in any one day.

The interest in a thorough study of the *internal macro and micro structure* of welds of many types and alloys, has increased by leaps and bounds in the last few years, due partly, to the stimulation of interest in this angle by the Army and Navy. It is necessary to take a strictly objective view of the importance of this thorough detailed investigation of welding procedure. Though it appears at times to hamper production temporarily, it finally yields sound interpretation of weld structure and works toward a more dependable product as well as a satisfactory production rate.

The result of the operation of the completed machine in military service, be it tank, plane, gun or ship, is not sufficient criterion of whether a job is good enough. The lag in time in receiving results of the operation of our war product in action, is too great to give any reasonably quick report on workmanship. This record is only

valuable in a long view of the development of the product being manufactured.

Therefore, it is of prime importance that the product, manufactured for use by the military personnel, be of the highest practical standards known to the manufacturer and the Army or Navy inspectors in charge. This appears to be a self-evident fact, but it is an ever present point under study by all supervision; consequently, the large number of specifications which are in use, and the intelligent interpretation necessary of these specifications in the light of the specific problem in hand.

Obviously, a standard of such rigidity and perfection that production would be impossible, or of insignificant volume, would be of no practical value.

So, a familiarity of the laboratory and production supervisors with current specifications as issued, covering the particular manufacturing operation, is very necessary along with a knowledge of application to the job of these specifications. This knowledge will assist in viewing all the possible tests available, destructive and nondestructive, in the light of their true and relative value.

Postwar Functions of the Chemical and Metallurgical Engineering Division in the Manufacture of Civilian Goods

It is apparent that the chemical and metallurgical engineering division has gained, in the last few *war years*, in particular, the reputation of substantially assisting in the production of goods, which, after all, is the final criterion of the success of a manufacturer, from a material and also a personnel standpoint. This is possible from

1. A reduction in scrap by careful processing and maintaining of uniform analysis and physical properties of material going on the job.
2. The taking advantage of processes and compounds nationally available for expediting manufacture.
3. Close metallurgical control in investigating new methods and developments of these methods into a producing unit, carried on in conjunction with the production division.

Summary

For a brief résumé of such a broad topic as the above, the following pertinent requirements of a chemical and metallurgical engineering division, are submitted for further study and comment.

First: The chemical and metallurgical division in a welding department should be staffed with personnel of broad experience in production problems, as well as sound technical background in chemistry and metallurgy. Only, in this way, is mutual appreciation of skills and cooperation of departments possible.

Second: Speedy metallurgical preparation of test information for the production department, is absolutely necessary. This facilitates prompt setting up of sound welding procedures and resultant early production. Maintenance of this standard in production is also expedited. A well-equipped laboratory, capably staffed, is required to give this service.

Third: All supervisors involved, including the mechanical engineering and design, chemical and metallurgical engineering division, and production engineering, must arrive at a *sound appraisal of the relative importance* of macro sections, tensile tests, visual inspection of welds, etc. This is extremely important, in determining just what is, a good weld.

Research in Welding

Chemical and metallurgical research in welding development is a study all by itself, much too important to be covered thoroughly in a discussion as brief as this. However, it is well to note that much of the valuable new developments are progressing daily in conjunction with the man on the job, sparked, of course, by the engineers of the research division.

A Casual Note in Closing, as to Technical Publications Review

A suggestion is added here for *discussion* and *comment*, for a much needed adjunct to the go-getting chemical and metallurgical engineering division in welding, i.e., a capable employee with suitable technical and production experience on assignment to cover current technical periodicals bearing on the particular welding jobs in operation in his plant. This employee would necessarily be well acquainted with the current problems of the associated departments. He would note all articles of vital interest and make abstracts of the same up to two or three hundred words. Some periodicals already carry brief outlines of articles which might well furnish one convenient starting point for obtaining this information.

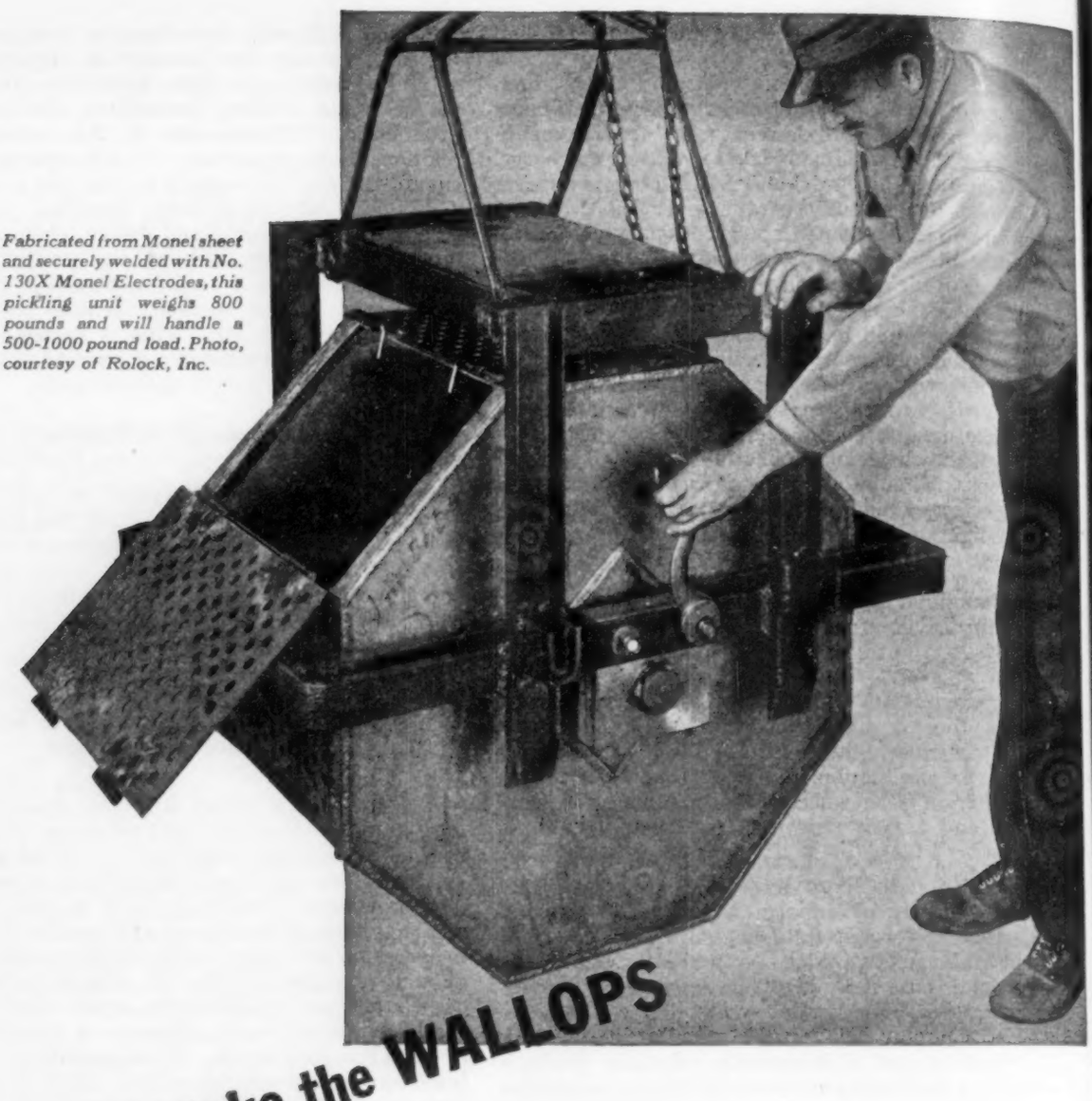
These abstracts should then be placed on file, and be readily available to the chemical and metallurgical staff, production, or any other supervision, interested in welding procedure. Further study could be made when the article abstracted, proved of immediate value. This technically trained employee should be in a position to carry on this additional study, toward application of these ideas in current production.

Who, among us, has not looked forward to doing justice to the fine current technical information available on welding and associated metallurgical problems? Such an arrangement, as the above, might well change our anticipation to realization.

1945 A.W.S. Directory

In order to conserve paper the new 1945 A.W.S. Membership Directory, now available, will be only sent to those requesting a copy. There is no charge to members of the Society. Address request to:

American Welding Society
33 West 39th Street, New York 18, N. Y.



Fabricated from Monel sheet and securely welded with No. 130X Monel Electrodes, this pickling unit weighs 800 pounds and will handle a 500-1000 pound load. Photo, courtesy of Rolock, Inc.

WELDS that take the WALLOPS

A rotating pickling barrel filled with small parts takes plenty of wallops as it spins through life.

And with every revolution bringing hundreds of impacts from the tumbling contents, the *length* of that life depends upon the soundness of the welded joints.

The above unit was designed and constructed by Rolock, Inc., of Fairfield, Conn. The barrel, made of 3/16" Monel sheet, measures 36" across the octagonal flats and is 24" wide. In use, the frame sets upon the edge of the pickling tank, with the barrel extending into the corrosive pickling solution.

Strong, rugged and corrosion-resistant Monel was the logical choice for equipment of this type. *And equally important* was the use of No. 130X Monel Electrodes for welding the seams.

By arc welding with No. 130X Monel Electrodes, sound, ductile welds were obtained, with strength and corrosion resistance fully equal to that of the parent metal.

Helpful engineering data and welding instructions are given in *"Welding, Brazing and Soft Soldering of Monel, Nickel and Inconel."* Send for your copy of this well-illustrated 32-page booklet.

No. 130X Monel ELECTRODES

THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL ST., NEW YORK 5, N.Y.

Unusual Applications of Gas Cutting to Ordnance Fabrication*

By C. M. Underwood†

THE design and production of Naval Ordnance is one of the major contributions to the equipment which is giving our Naval Forces an ever-widening superiority over our enemies. One of the largest producers of Naval Ordnance is Northern Ordnance, Inc. This concern was formerly a small organization manufacturing fire pumps and miscellaneous hyraulic equipment. In October 1940, in anticipation of drastically increased armament needs, it abandoned its plant facilities in Minneapolis, secured a 400-acre site in the suburbs and started building an ultra-modern ordnance plant. In spite of unseasonable weather, buildings were completed, machines were installed and production was under way early in January 1941.

It was immediately seen that outside sources could not be depended upon to keep a machine shop of this magnitude supplied with the major fabricated structures it would need. Accordingly, a welding plant was soon under way and by late February 1941, gun mount weldments were being fabricated in the new welding building.

One of the many items which required special attention in this new fabricating plant was the gas cutting department. The Naval Ordnance structures being manufactured have numerous exacting requirements and their quality and workmanship must exceed the best commercial practices. Dimensional tolerances are extremely small, particularly for such large structures. Inspection standards are severe; X-ray and Magnaflux were used profusely. To operate acceptably under these abnormal requirements, all component parts of the structures must be carefully prepared.

The methods used to insure precision cutting vary with the job, and may in numerous cases involve special jigs and cutting equipment. In other cases special means of lining up the machine to the work are provided, and sizing operations upon the finishing or semifinished weldment itself are often employed. Since a thorough discussion of ordnance cutting would require more than one technical paper, this discussion will cover only the special or less commonly employed practices, under the assumption that standard cutting practices are sufficiently known to require no restatement. While the emphasis here will be given to precision cutting and the setups developed to provide high-quality work, it should be made clear that a good amount of standard cutting by conventional methods is also done at Northern Ordnance.

Designing for Welding

Before going into detail on this subject I should like to digress a moment to give a little of the background on the Naval gun mounts being fabricated. These gun mounts were originally made of steel castings, but in anticipation of large-scale production in a market where high-quality steel castings would not be readily available, the Navy has gone to welded fabrication. Aside from redesign of major parts to use available materials and to facilitate production, our engineering department has had the problem of redesigning numerous minor cast parts to weldments. When such a change-over is indicated the mechanical engineers, are given the original problem of redesigning each part. They consider the fundamental requirements, design the part to operate functionally and frequently end up with a structure that appears to have little relation to its cast predecessor.

When a preliminary layout is completed it is turned over to the welding engineering section where it is analyzed from the standpoint of feasibility for welding, and if necessary, altered by the welding engineers to a design that may be more readily fabricated. The layout is then returned to the mechanical section where a final layout is made that is mutually satisfactory. Detailed welding drawings are then made by the welding engineering section, which takes full responsibility for the success of the weldment. A close relationship exists between the engineering sections, and there is correspondingly close liaison between the welding engineers and the shop. If, when production is under way, the welding foreman finds something that does not work out quite right, or that could be done more easily in another way, he comes in to the engineering department to consult on making changes. Likewise, in the course of making the original design, the engineers frequently go to the shop to consult the foremen about the feasibility of any details of the job. One reason for this close harmony is the simple fact that the welding engineering section is located in the shop, without the usual "front office" barriers between the engineers and the shop personnel.

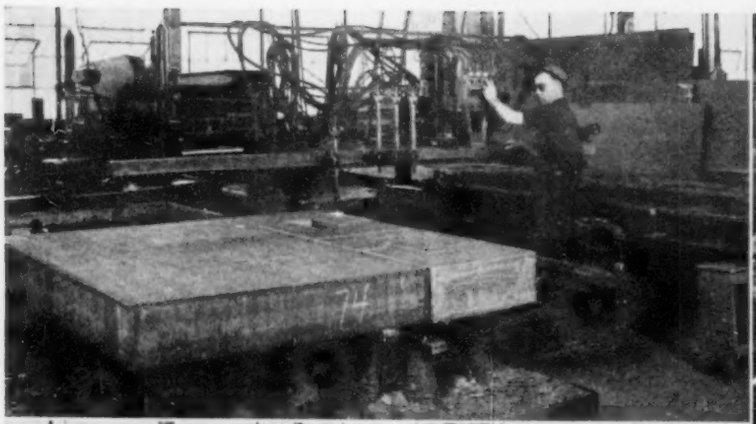
Thus designs are established. In some cases the new design calls for the use of rolled plate only; in others, a certain portion of the assembly which may be too irregularly shaped to fabricate economically will be cast or forged, and then welded into the plate assembly. In such cases both forgings and castings may be used to insure a sound product. Over a period of time, most cast steel parts in the entire gun mount have been converted from cast to fabricated construction. Typical applications of these practices follow.

Multiplane Cutting

One of the simplest pieces in the gun mount is the rear plate, which is at the same time one of the most interesting gas cutting jobs since it involves cutting and shaping

* Presented at the Twenty-Fifth Annual Meeting, A.W.S., Cleveland, Ohio, Oct. 16 to 19, 1944.

† Manager, Welding Dept., Northern Ordnance, Inc.



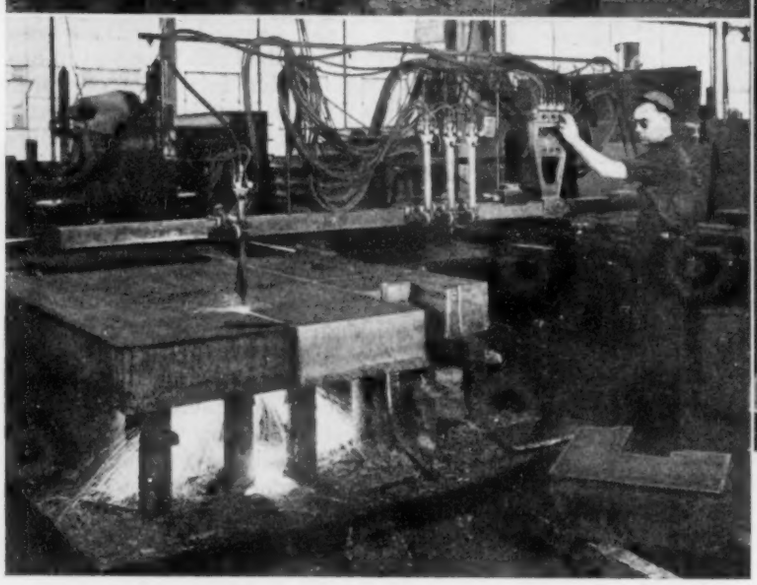


Fig. 1 (Top)—Cutting Gun Mount Slide Rear Plate from 8 1/2 In. Steel, Using Multiple Template and Travograph

Fig. 2 (Bottom)—Profiled Block at Right Shows Smoothness of Cut. Note Construction of Work Supports, Preventing Finished Parts from Tumbling

Fig. 3—Close-up of Template Used in Fig. 1. Six Identical Cams with Movable Gates Enable Continuous Passage of the Torch

in several planes. This piece is a single block of 1020 steel 8 1/2 in. thick and weighing about 800 lb. finished. Our object here in changing from a casting to rolled plate was not to effect a change in design, but to obtain consistently sound material and to avoid the difficulty in machining to close tolerances surfaces containing cast-in sand which is frequently encountered. The piece as cut is in fact identical in shape to the original casting.

As shown in Fig. 1 these pieces are profiled one at a time on a Travograph using a multiple template which enables six identical pieces to be cut consecutively without changing the work setup. Special supports for holding the workpiece were constructed of lengths of 5-in. steel tubing, arranged exactly in position to support each cut piece without tilting, yet permitting the small scrap sections and torch blow to fall through. This feature is illustrated in Fig. 1, where the finished severed sections remain in place without jarring the workpiece, as they might if allowed to fall upon severance. The scrap pieces, incidentally, are not wasted but supply material from which the base ring centering pin housing is forged.

The high quality of cutting on this operation is clearly demonstrated in Fig. 2, in which the finished part at the lower right shows extremely smooth faces and unusually sharp top corners. Careful observation of the quality of cut secured with the Travograph at different speeds and gas pressures has resulted in the establishment of exact procedures for this cutting job. Another factor promoting accuracy here is the template, shown in close-up in Fig. 3. This template is in six identical nested sections, mounted on a single base on rollers for easy handling. Movable entrance gates enable the magnetic tracing roller to move from one finished profile cut to the start of the next without interruption. These gates also guide the torch in from the outside edge of the plate to the first line of cut without manual operation, thus insuring a smooth, regular cutting action of the oxygen jet through the 8 1/2-in. plate at the introduction of the cut.

After profiling, the 920-lb. blank is mounted on a jig for flame shaping in several planes with the torch and Planograph. The first of four shaping cuts, a 6-ft. radius cut made at a bevel of 25° 30′, is shown in progress in Fig. 4. Accuracy in locating this cut is insured by alignment of the torch and the manual tracing template to prick punch marks made directly on the workpiece, which is itself mounted positively in position by being clamped to the rotating table of a trunnion-mounted jig. This jig indexes in two directions, with locking stops at 90° positions. It holds two of the workpieces in counterbalanced positions.

The second shaping cut, geometrically similar to the first, is made with the piece pivoted 180° from its first position, as illustrated in Fig. 5. Figure 6 shows the third cut in progress. Notice here that both of the first

two cuts stopped short of the end of the workpiece, upon which the prick punch marks and scribing for the third cut were made. This cut is made after indexing back 90°, and follows a shallow U contour, consisting actually of three straight cuts with 12-in. radius curves at the intersections. The fourth cut rounds off a corner at the end of the long leg of the piece. The cut faces are finally ground to round off the intersections of these shaping cuts to the 6 ft. radii. Figure 7 compares the cast pieces with the flame-cut pieces, showing little observable difference between them. Thus our purpose of making a gas-cut part serving the same purpose as the cast part was achieved. The wrought material cost is about one-third of the casting cost; machining time is less; the fabricating time of the cut plate is about equivalent to the average repair time for casting defects.

Cutting on Base Ring Structurals

The largest single part of the gun mount is the base ring, upon which the gun rests and rotates. This assembly involves considerable cutting and welding, all of which must be accurate to preserve alignment and avoid unequal contraction of welds, such as would occur if Vees were unequal in size.

Fig. 4—First Shaping Cut on Profiled Rear Plate. Note Indexing Positioner Which Holds Workpiece. Manual Tracing Device Is Used on Planograph, and Cut Is Interrupted as Shown in Fig. 6

Fig. 5—Second Shaping Cut on Rear Plate. Piece Was Rotated 180° in Fixture for This Cut

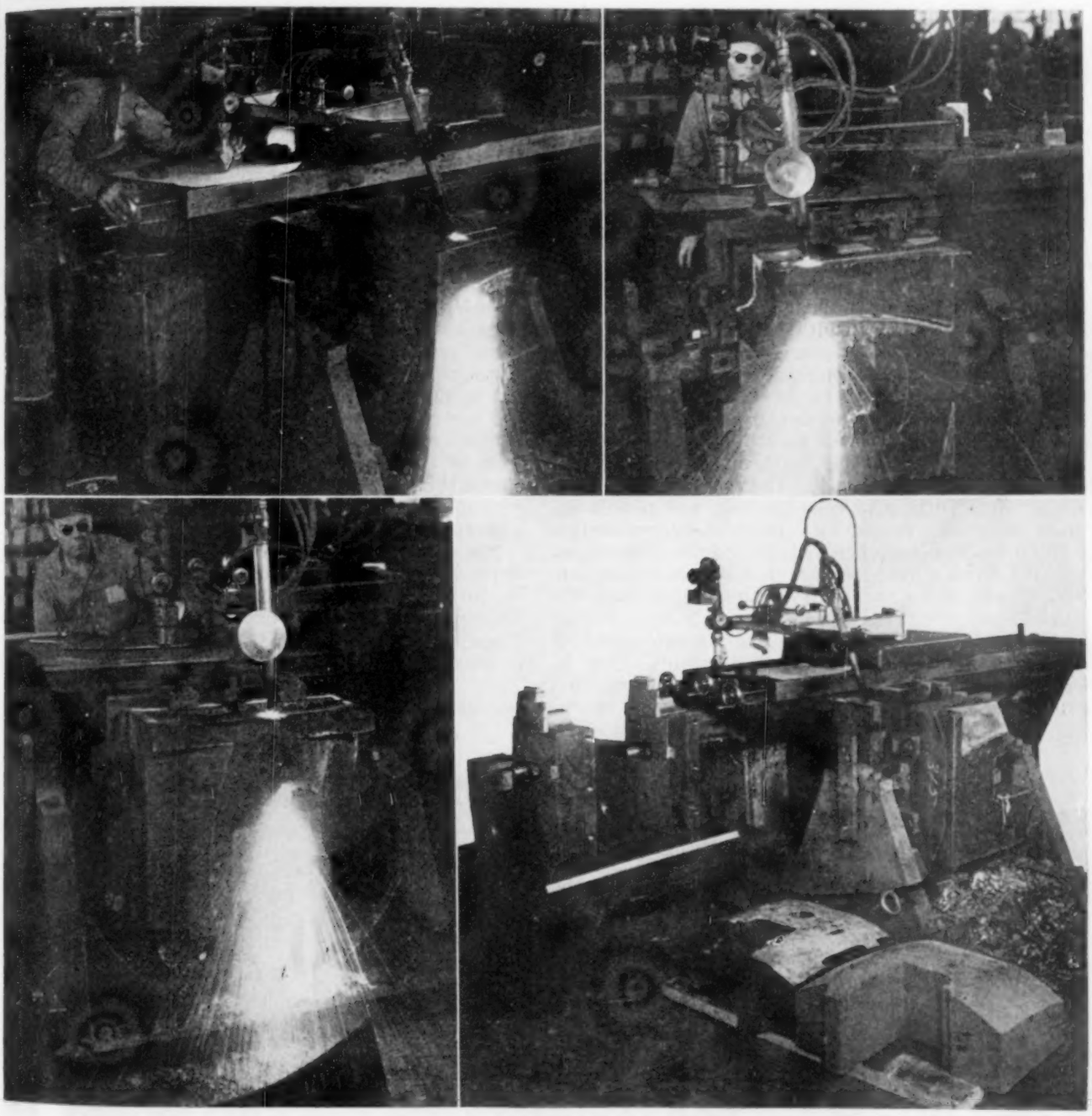


Fig. 6—This Third Cut Virtually Completes the Rounding of the Back of the Rear Plate. Intersections of Cuts Are Finished by Hand Grinding

Fig. 7—Comparison of Rear Plates Made from Cast Steel and Gas Cut from Rolled Plate, Showing Both Types in Rough State in Foreground, Finished on Table at Left. Gas-Cut Plate Is at Right in Both Groups

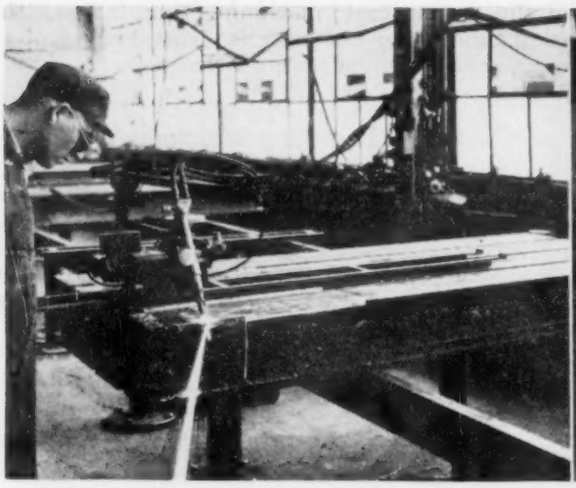


Fig. 8—Accurate Beveling Is Done by Cutting Bevel Into a Vertical Cut, Both Made with Radiagraph

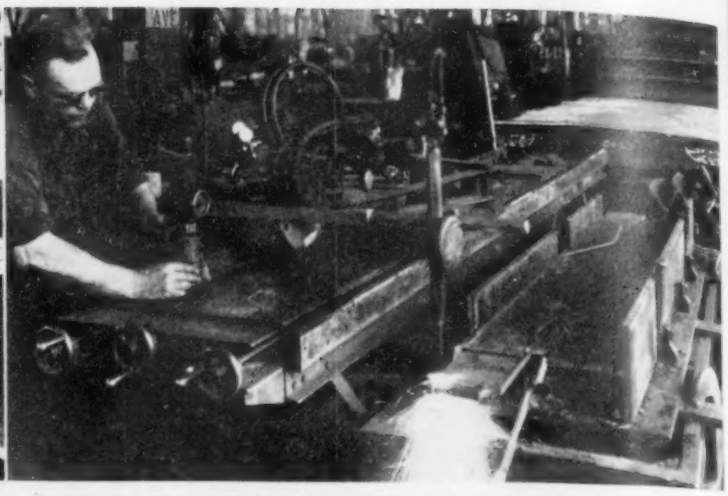


Fig. 9—Cutting Outline from I-Beam for Gun Mount Base Ring Central Girder, Using Modified Planograph Cutting Machine and Work-Holding Fixture

The Carnegie beam shapes forming the basic structure of the ring vary in height by $^1/_4$ in., the rolling mill tolerance, and must first be brought down to uniform height. This is accomplished by a sizing operation on a 350-ton hydraulic coining machine which we built specifically for this purpose.

Cut lengths of beams are then trimmed and beveled on those portions of the flanges which will be framed in with other members. The beveling could be done directly without prior trimming of the flange. However, because of the variation in flange width due to mill tolerances, all joint areas are sized to a square face by gas cutting a fixed distance from the longitudinal beam center line. The Radiagraph shown in Fig. 8 is cutting a bevel joint face in an area which has previously had a vertical sizing cut. We aim for a zero root face, but allow as much as $^1/_{16}$-in. root face on this 30° bevel, rather than risk cutting beyond the root corner. The face of the bevel is ground after cutting to remove scale and permit accurate Magnaflux inspection. Incidentally, production on this operation is speeded by loading a row of beams on greased rails at working height, enabling the operator to move quickly from one beam to the next or push the finished parts along the processing line.

The central girder of the base ring presented a minor problem when fabrication was first begun. This T-shaped member was first made by joining two long plates into T formation by welding. Distortion in this long weld was sufficient, however, to cause misalignment, and so the method of fabrication was changed to that shown in Fig. 9. A standard 18-in. CB section forms the basic material of this member, but all of the one flange and parts of the web and second flange are cut away with the torch. Tolerances of $^1/_{32}$ in. are maintained in cutting this irregular shape with a Planograph.

In the rapid production setup shown in the illustration, the beam is fixed positively in position by wedging the right-hand flange against stops bearing against the inside of this flange. The steel template is mounted permanently onto an extended tracing table, which is itself adjustable by means of three handwheels shown at the left in Fig. 9. The center handwheel moves the table top and template lengthwise, while each of the outer handwheels controls transverse movement of opposite ends of the tracing table. These quick adjustments enable the template to be lined up accurately in position with relation to the first workpiece, and facilitate minor adjustments for succeeding pieces as well.

The sequence and direction of cuts are also calculated to preserve accuracy by reducing creep in the beam during cutting. All cuts are made from the ends to the center, two such cuts being made to remove the left-hand flange. A long cutting tip is employed to give clearance to the torch when cutting the web close to the flange. These cuts are subsequently beveled with a Radiagraph as illustrated in Fig. 10, maintaining a tolerance of $^1/_{32}$ in. as in the preceding operation.

Fig. 10—Gas Cutting Accurate Bevels on Central Girder for Gun Mount Base Ring

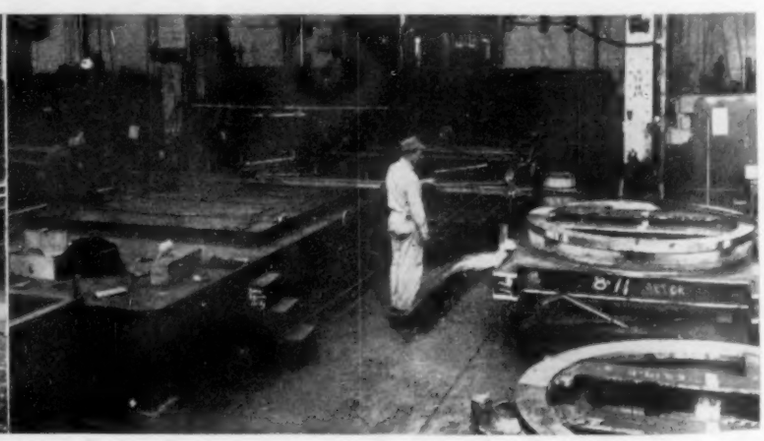


Fig. 11—Trimming Gun Mount Base Ring After Welding, Using Airco No. 41 Travograph and an Elaborate Magnetic Cam

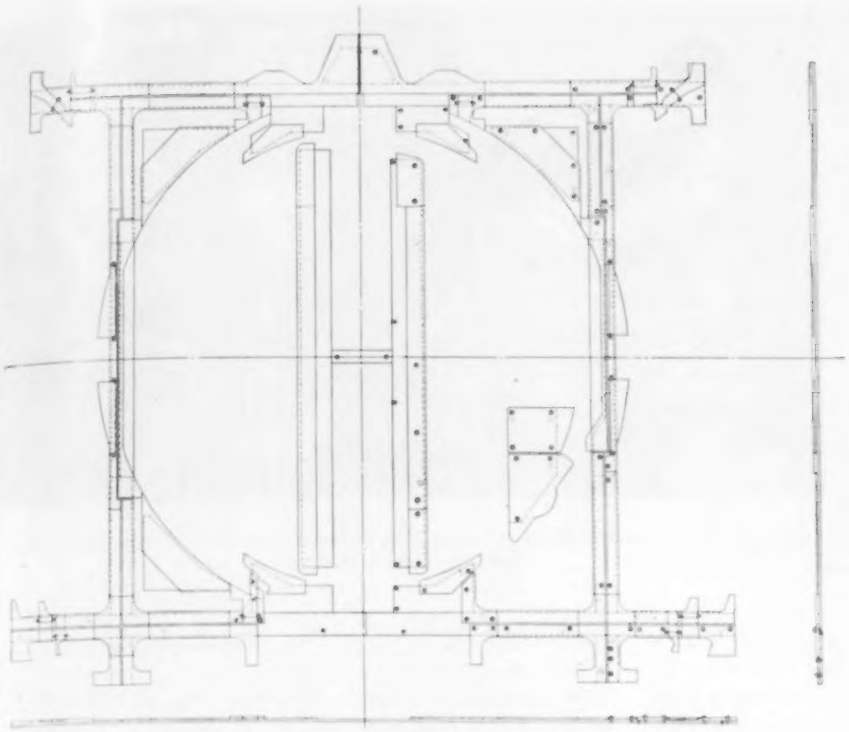


Fig. 12—Outlines of Multiple Phase Template Used in Fig. 11. A Total of 28 Different Cuts Are Made, Using Hinged Gates at Numerous Points

arrangement which is notable for the precautions taken in the interests of precision cutting. The Travograph is a standard model, with additional arm stiffeners, but its running tracks were mounted and leveled on the floor so accurately, with the aid of a precision level, that even the effects of direct sunlight caused noticeable changes. The template in Fig. 12 is actually three templates in one, with different portions painted red, green and blue according to whether they are used for cutting the inner and outer areas of top or bottom flanges of the workpiece. It is rigidly constructed on a base plate with cross bracing on the underside. Allen head set screws were used to fasten the various elements of the cam to the base plate, enabling fine adjustments to be made after the cam was initially assembled and before the operating surfaces were doweled to the base plate.

The base ring, which must be trimmed on both upper and lower surfaces, is mounted on a carriage which may be rolled into working

Travograph Setup on Base Ring

An unusual situation arose after production of fabricated gun mounts had been under way for some time, when the Navy Department asked us to alter the design of the base ring to reduce its weight. These alterations did not change the fundamental design of the ring but involved principally reductions in the width of flanges and other supporting members of the structure. It was decided to trim these members after assembly welding had been completed, since to do so beforehand would have required extensive changes and redesigning of cutting templates, tacking jigs and welding setups all along the production line. The feasibility of making the changes by gas cutting after virtual completion of assembly welding is an excellent demonstration of the flexibility of the flame cutting and arc-welding processes. While both the size and production quantities were large enough in this case to necessitate a fairly elaborate setup for making the changes, the cost was still quite low in comparison to what is normally involved in changing the design of a part in production.

Reference to Figs. 11 to 13 shows how this job was done. A special three-part template, a track-mounted worktable and a large No. 41 Travograph were installed in an

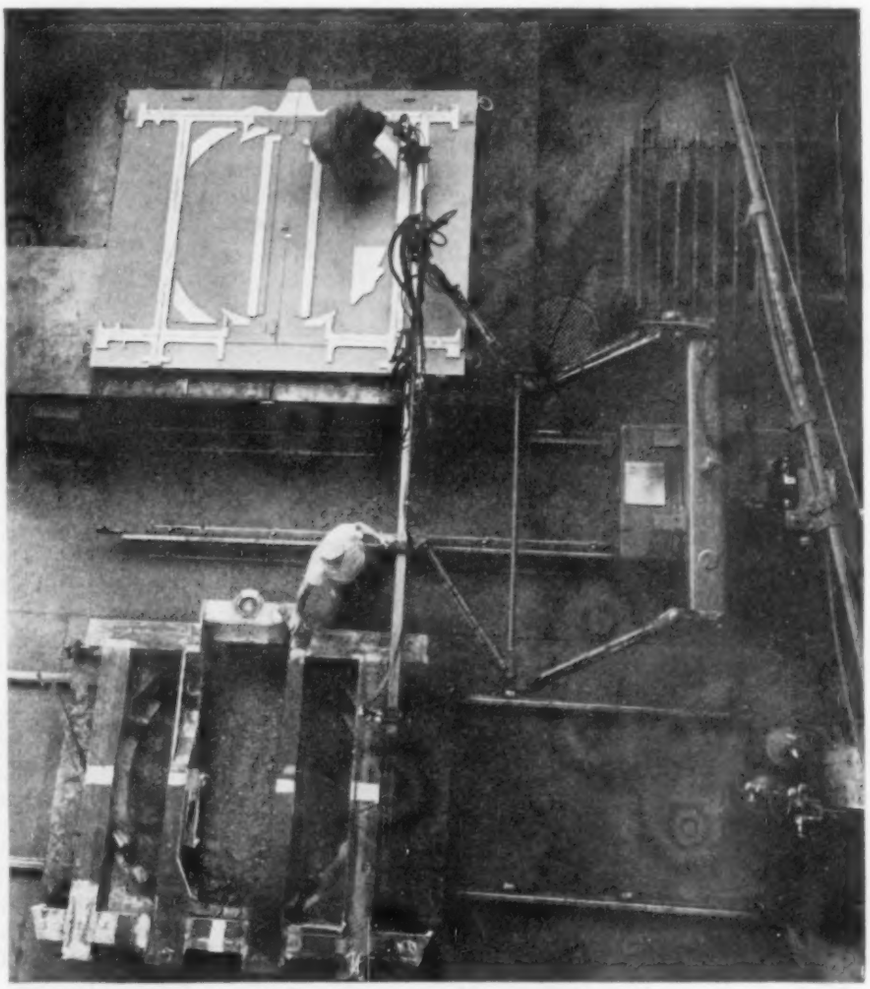


Fig. 13—Overhead View of Base Ring Trimming Operation, Showing Travograph, Template and Track-Mounted Cutting Table

position on floor tracks. The parallel positioning of the base ring with relation to the template may be adjusted by means of a hand crank which rotates the worktable on the carriage. A hand-brake locks the carriage to the rails in cutting position. Precision alignment is quickly secured by the following method. The torch bar is moved out to locate the magnetic tracing roller in a locating block fastened to the center of the template base plate. Two plumb bobs about 8 ft. apart on the torch bar are then located over the scribed center line of the base ring, and the ring is shifted to bring this line exactly beneath both bobs. A third plumb bob mounted directly on the torch clamp is then used to position the torch laterally on the horizontal bar to bring it above the transverse center line scribed on the ring.

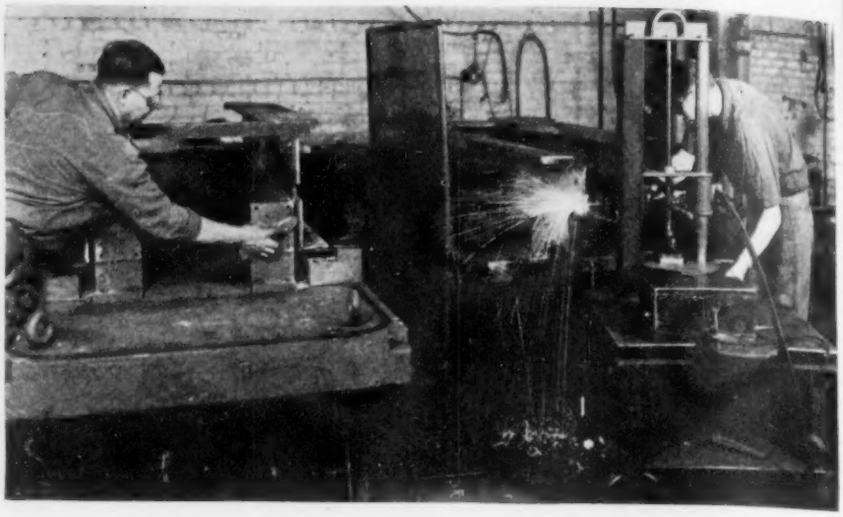


Fig. 15—Layout and Trimming on Base Ring Subassembly, Using Sizing Fixture and Vertical Cutting Machine

Eight separate cuts are made on a major subassembly of this fabrication with the tracing roller following the blue segments of the cam, removing strips of metal from the inside of the ring, in areas that would be inaccessible in the completed weldment.

Final cutting begins with the completed ring weldment inverted as in Fig. 11. One and one-half inches of metal are trimmed off of the outer periphery as well as the two center girders within the ring, following the red portions of the template. A total of fourteen cuts are made in this sequence of operations.

The base ring is then turned right side up and aligned for making ten different cuts from the green segments of the template. Many of these cuts follow the same paths as the red paths used previously, except for deviations at various points. The same working edge of the template is used for the common portion of both cuts, the deviations being taken care of by hinged extension segments which are turned over into the line of the tracer travel when needed. A close scrutiny of Fig. 12 will reveal fifteen of these hinged segments of the cam. Cutting tolerances of $^1/_{32}$ in. are maintained even though the structure is relatively large and intricate.

The overhead view of this installation given in Fig. 13 shows the worktable and tracks, with adjusting screws for positioning the base ring at the left. One of the plumb bobs is mounted on a perforated extension to the torch bar. Another feature of this installation is the jib boom for carrying oxygen and acetylene hoses conveniently to the cutting machine.

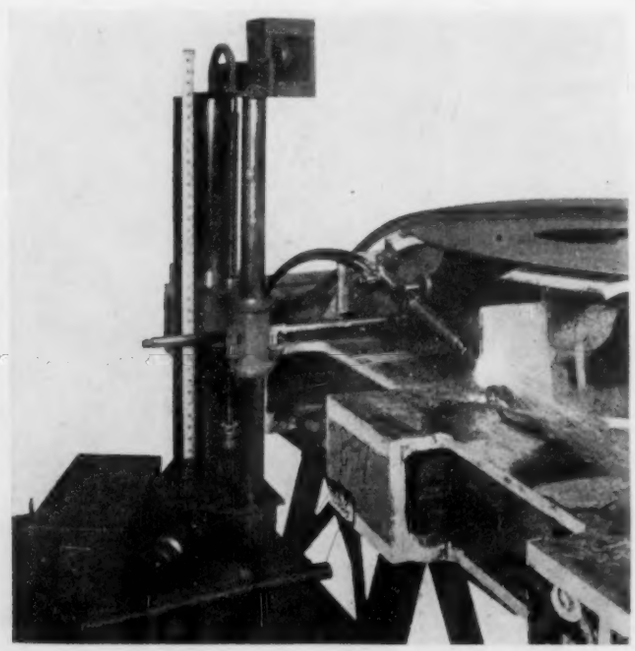


Fig. 14—Post-Welding Trimming Operation on Base Ring, Employing Special Vertical Cutting Machine. Close Tolerances Must Be Met in This and Other Final Trimming Operations

Vertical Cutting

There are a number of points on the base ring assembly which must locate very accurately with relation to corresponding parts on other subassemblies. The end plates, for example, must be sized very accurately, meeting closer tolerances than could invariably be obtained in a jigged and welded assembly. To avoid inaccuracies and the resulting need for correction, we adopted the method of making these parts $^1/_4$ in. or more oversize in the primary fabrication, and cutting them down with the torch after completion of welding. Since some of these cuts were vertical, we designed and built a number of the vertical cutting machines illustrated in Figs. 14 to 16. These are now used also in intermediate stages of fabrication.

One of the final trimming operations is shown in Fig. 14, with the torch moving upward on the free end of a CB web. The cutting machine consists of a torch mount which slides on two guide shafts, with vertical motion provided by a central screw. The screw is powered by a standard gas-cutting machine motor. It may be driven in either direction and operated at any desired cutting speed by setting the governor. This provides a speed range of about 3 to 20 in. per minute. The equipment is mounted on a base with three leveling screws, the whole being placed on a four-wheeled carriage having drop legs for steadying the machine during use. The machine can therefore be readily moved into position for each job. The four-wheeled carriage is also equipped with a crank-operated lifting device which permits raising or lowering the cutting machine to the desired height.

In Fig. 15 the method of scribing and cutting on the central subassembly is pictured. This subassembly is made with trim stock at all points which subsequently will go into a welded joint. It is placed in the sizing jig at the left in the photo, where the operator scribes the sections to be trimmed by sliding a flat scriber knife against locating pads as shown. Cutting is done in the adjacent work station, observing a tolerance of $\pm 1/32$ in. The face of the cut is then ground to a tolerance of $+0$ $-1/32$ in.

The versatility of this cutting machine is further demonstrated in Fig. 16, where it is used in conjunction with a turntable for rotating small workpieces before the torch. This turntable also has reversible and variable speed, being powered by the same type of motor as the cutting machine. A rectangular opening in a tubular weldment is being cut here, by giving motion alternately to the turntable for the horizontal cuts and to the vertical driving mechanism for the vertical cuts. Rounded corners are obtained at the changes in direction of cut simply by switching the dead motor on a few moments before turning the live motor off.

Fig. 16—Machine Consisting of Power-Driven Turntable and Vertical Cutting Machine Is Here Used to Cut a Rectangular Window in a Tubular Weldment

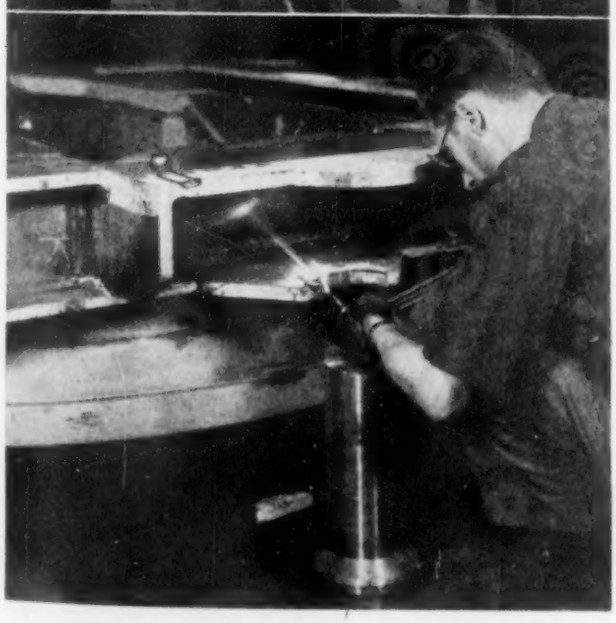


Fig. 17—Manual Beveling of Base Ring to Receive Centering Pin Housing Shown in Foreground

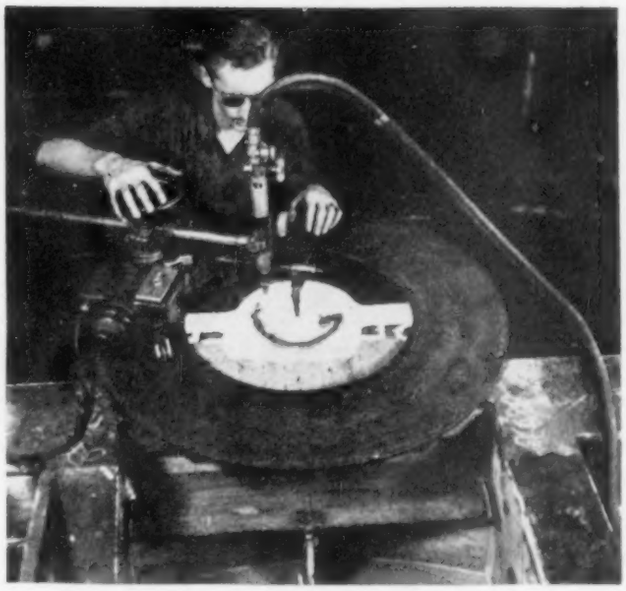


Fig. 18—Cutting Opening for Centering Pin Housing. Concealed Clips Prevent Circular Track from Tilting When Radiagraph Runs Out at Rear

Smaller Cutting Operations

Among the many cutting operations performed in the fabrication of gun mounts only a very few are done with the hand torch, and then only because a machine cannot readily be brought into play. Figure 17, for example, shows a semicircular bevel cut being made on the par-

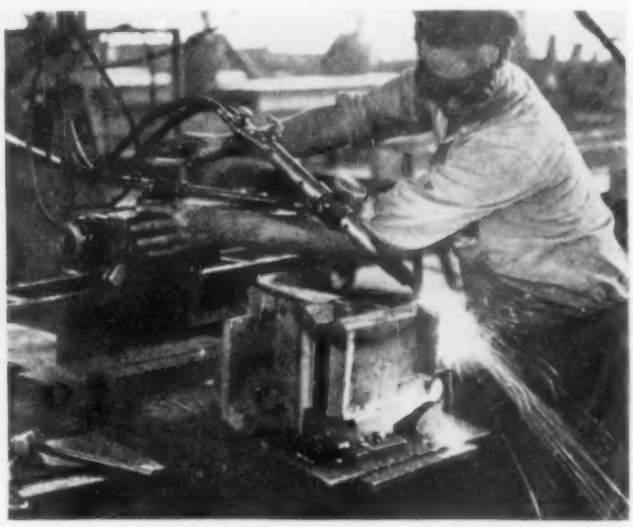


Fig. 19—Gas Cutting Bevels on Steel Casting Preparatory to Welding This Part Into a Plate Assembly. Extreme Accuracy Is Maintained in Cutting

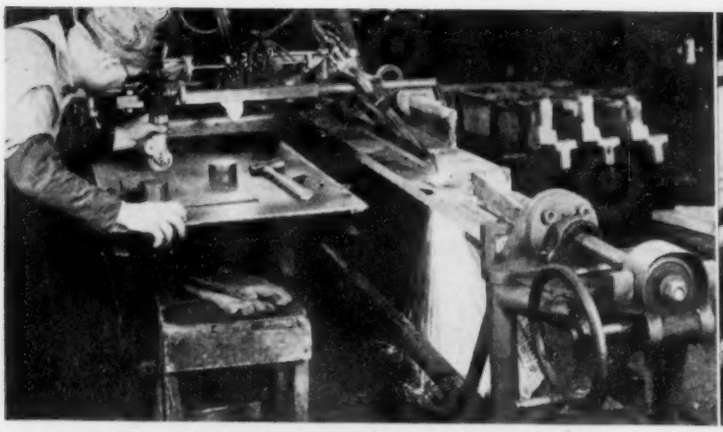


Fig. 20—Rammer System Cover Plate Weldment Is Positioned in Fixture for Accurately Cutting Numerous Small Openings. This Complex Part Was Formerly Made by Casting

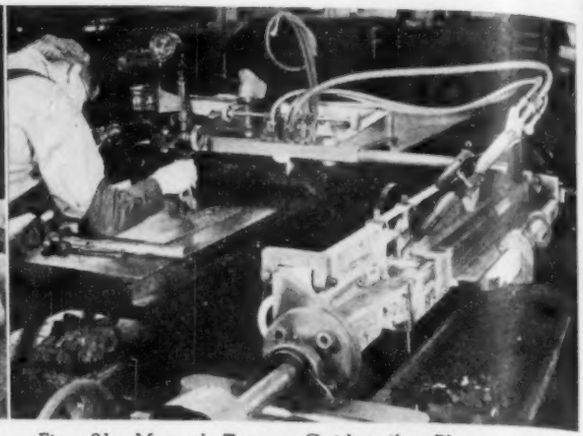


Fig. 21—Manual Tracer Guides the Planograph in Cutting Small Openings, Using Bent Tip to Clear Adjacent Vertical Surfaces

tially assembled base ring. Like some of the other cuts described previously, it is made after fabrication of the ring is almost completed, in the interests of accuracy, since it forms part of the weld joint for the centering pin housing. This rough bevel is ground smooth and to exact dimensions.

The cutting of the upper support for this centering pin housing is illustrated in Fig. 18. The center point for this circle is laid out after the entire ring is completed, and prick punch marks are laid out at frequent intervals along the line of cut, as a guide to the operator to insure exact cutting with the Radiagraph. After this operation, the hole is beveled and ground, and the pin housing welded in. This housing is bored to receive the centering pin during final machining.

An illustration of material preparation for a composite structure is shown in Fig. 19. This is a portion of the rammer system cover plate, formerly a complete casting but now made by welded fabrication and employing this end piece casting which is impractical to fabricate. For welding this casting into the over-all assembly, numerous joint areas must be prepared. The unsound cast surface is removed and the joint areas squared and sized by a machining operation, to form accurate reference points for cutting the double bevels. These bevels are then cut

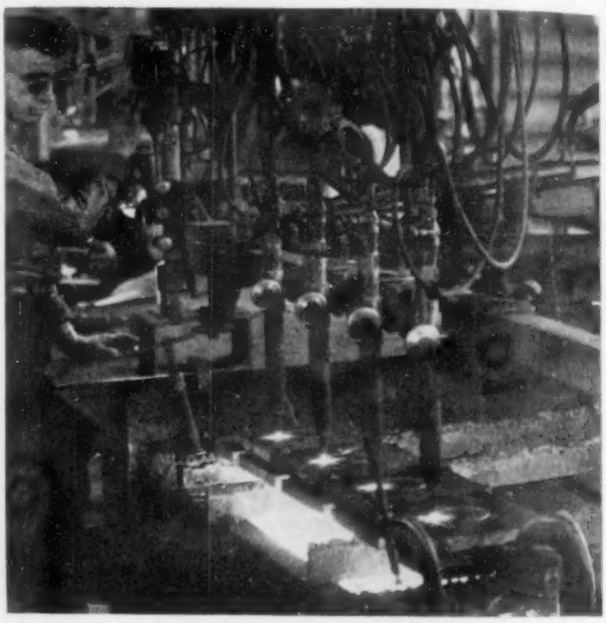


Fig. 22—Locating Pins Hold Individual Plate Squares Accurately in Position for Cutting Circular Openings in Multiple

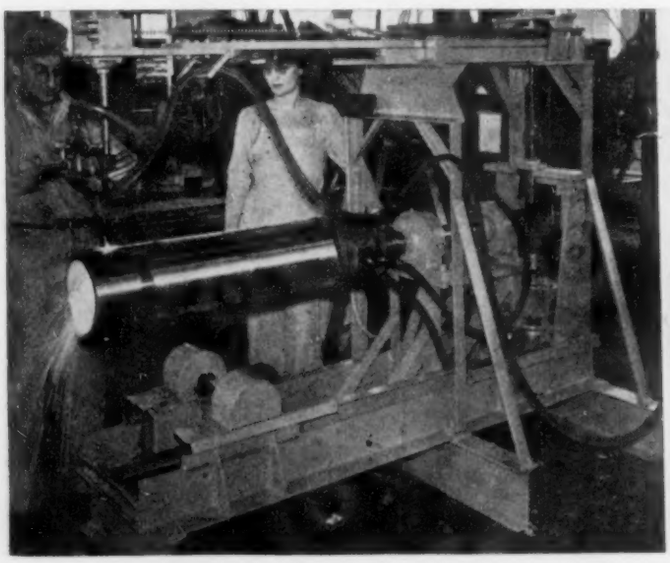


Fig. 23—This Machine Automatically Cuts Beveled Holes in the Gun Mount Slide Tube to Receive the Connecting Trunnions

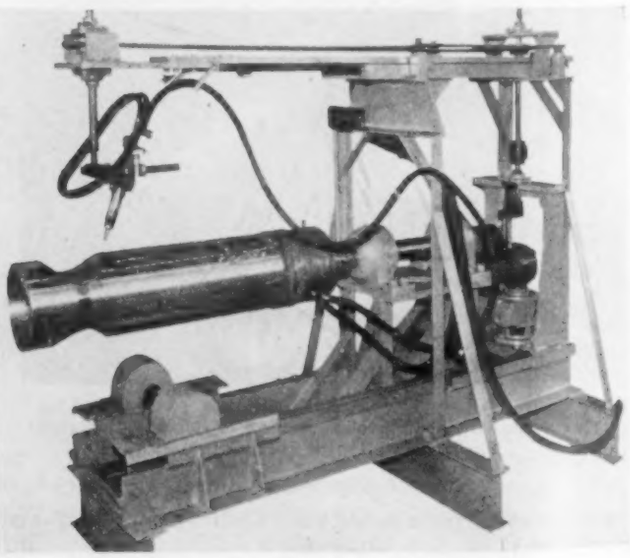


Fig. 24—Finished Beveled Openings Cut in Gun Mount Slide

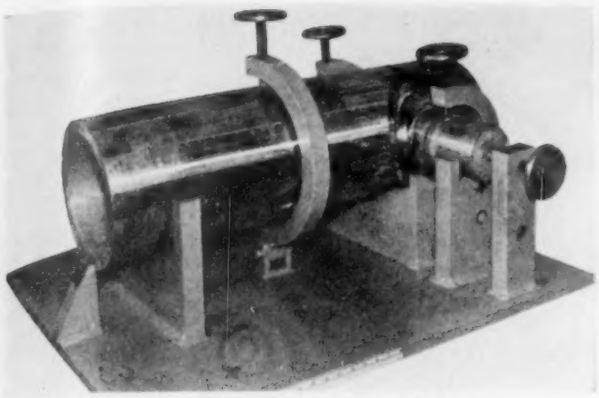


Fig. 25—Gun Mount Slide Showing Assembly of Trunnions and Tube for Welding. Both Parts Are Gas Cut Automatically to Exact Contour

by the Radiagraph running on a suspended track as shown, adhering to the usual $^1/_{32}$-in. tolerance.

The rammer system cover plate mentioned above presented a rather unusual problem in fabrication procedure, due to a number of small openings in the part. When we were having this cover plate made as a casting we machined these openings at first, but as this was an expensive set-up operation, we later changed to gas cutting on the castings. This saved time, but did not assure us of a perfect job, as the castings were not always sound and were sometimes received in a warped condition. Therefore despite the complexity of the piece we converted all but the aforementioned end section to a welded fabrication. This assured us of sound metal and control of distortion, but still left the problem of locating the small openings in exact position with relation to other elements of the structure. To guarantee accurate positioning it was decided not to make these cuts during the initial flame cutting of the component parts, but to make them on the finished weldment. Figures 20 and 21 show the setup devised to accomplish this.

The piece is mounted on a positioner constructed of welded tube, which provides 360° rotation in one plane and is closely adjustable through a worm and gear as seen in the foreground in Fig. 20. Since some of the cuts are made in corners close to vertical faces which would interfere with normal torch operation, a 45° bent tip is used as shown. The cuts are made with a Planograph and manual tracer, employing a type of template widely used in the cutting department—a piece of prestwood engraved with the template outlines in the form of shallow grooves which receive the tracing wheel. Prick punch marks laid out on the workpiece serve as reference points in lining up the template for cutting. In Fig. 21 the piece has been turned 90° and a small opening is being cut on the opposite side. Faintly discernible in the rear is a small bevel cut, made in a few minutes with the torch. Formerly this bevel was machined, an operation which required materially longer for setting up and milling.

Before leaving the subject of small parts cutting, mention should be made of another method of handling such parts. In Fig. 22 an Oxygraph with four torches is cutting circular holes in square side plates for pump housings. Rather than cut four holes in a single plate and then cut the plate into squares, the squares are cut first, the edges machined and faces surface ground. Four of these plates are then fitted into individual jigs on the cutting table. These jigs consist merely of round steel pins set in a base plate which is cut out on the underside to permit slag and scrap to fall through. Six pins hold each square plate exactly in position while the center hole is cut out. Unusually close dimensions are obtained by this method.

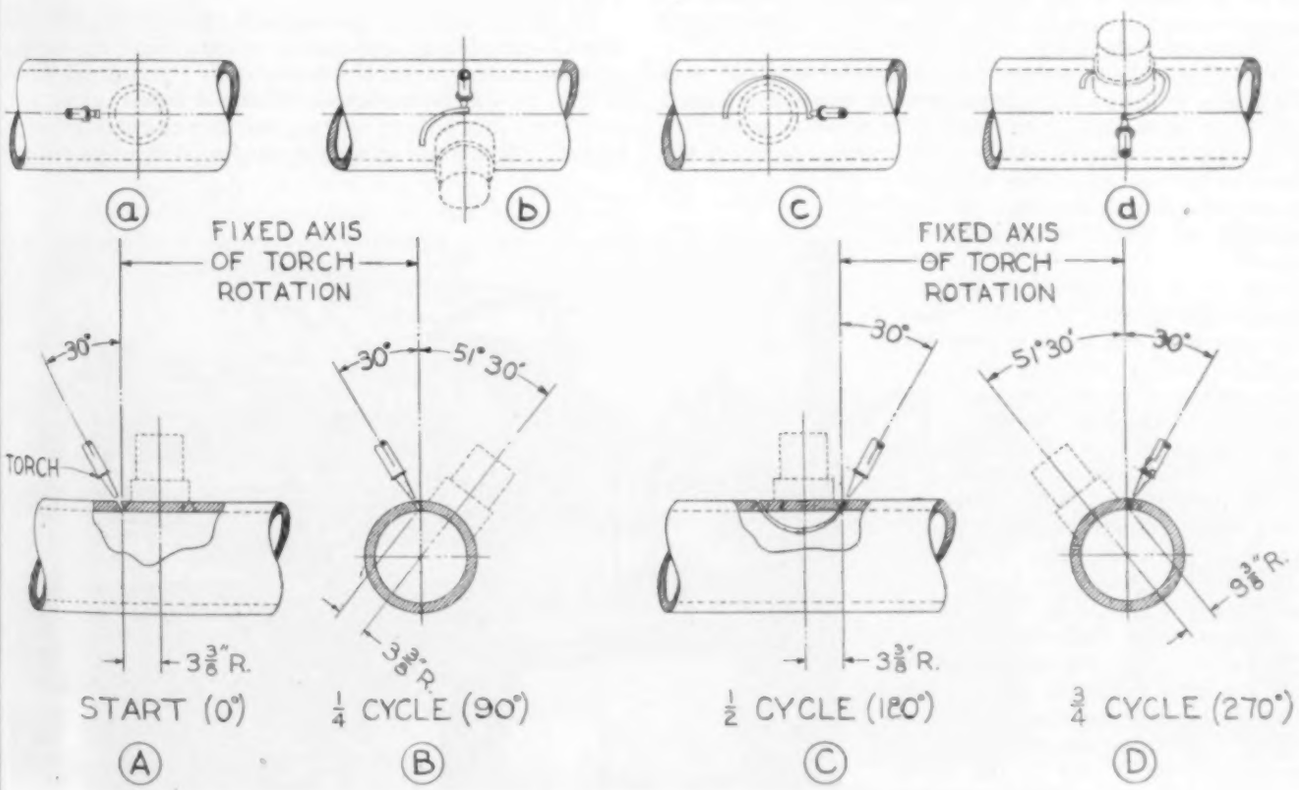


Fig. 26—Synchronization Sequence in Gas Cutting Beveled Hole in Tube

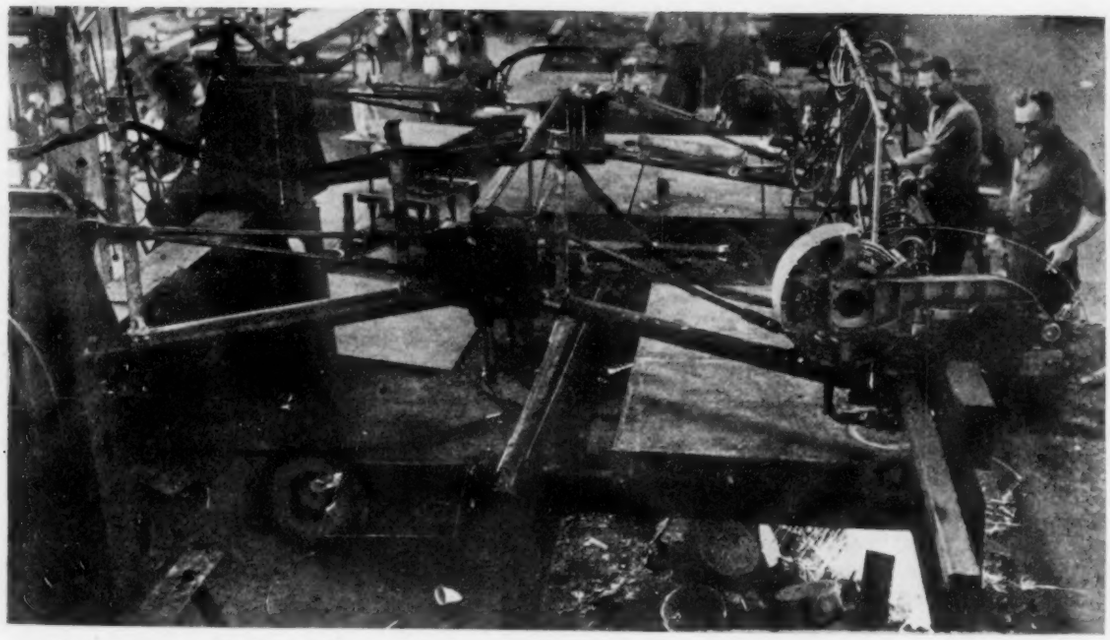


Fig. 27—Multiple Cutting of Trunnion-Bearing Blocks from 4 1/2-In. Plate, Using Special Pantograph Cutting Machine

Tube Cutting Machine

One gun mount slide is a tubular sleeve with trunnions which hold the gun barrel and permit depression or elevation of the gun to the desired angle. The welded joints between the tube and the trunnions must obviously be sound welds, since they must withstand the shock of the full firing load. The first step in this process was the actual designing of the weld joint, meaning the shaping of the beveled edges for proper disposition of weld metal in a weld of constant cross section. Figures 23 to 25 illustrate the special gas-cutting machine designed to cut beveled openings in the tube and the mating bevels on the trunnions.

The tube, approximately 10 in. diameter and 1 in. wall thickness, is held on a compressed air expanding chuck which is motorized both axially and rotationally, to bring the line of cut on the tube surface beneath the torch. The motion of the torch is synchronized with the tube motion rotating at the desired angle of bevel.

The cycle of operation is illustrated in Fig. 26. *A* and *a* show the tube with the torch in place immediately after starting the cut. The trunnion is shown in dotted lines in its ultimate location. At one-quarter cycle, the torch has rotated 90°, the tube has moved 3 3/8 in. to the left and rotated 51° 30′ clockwise as illustrated in *B* and *b*. At one-half cycle the torch has rotated 180°, the tube has moved to the left 6 3/4 in. (the diameter of the intersecting trunnion) and rotated 51° 30′ counterclockwise bringing the trunnion center line back to vertical as illustrated in *C* and *c*. At three-quarters cycle as illustrated in *D* and *d*, the torch has rotated 270°, and the tube has moved 3 3/8 in. to the right and rotated 51° 30′ counterclockwise. To complete the cycle, the torch continues to 360° rotation, the tube returns 3 3/8 in. to the right and rotates the trunnion center line 51° 30′ clockwise back to vertical. The beveling of the trunnion is done with the torch and trunnion mounted and moved in such a way as to cut a bevel exactly corresponding to the bevel in the tube. The two assembled pieces form a Vee. This same machine may also be used for welding as it automatically positions the work and brings the joint under a fixed position at any selected constant speed.

Figure 25 shows the parts set up in a tacking jig. The joint is backed up with a split length of pipe during welding. This pipe and the root of the weld are machined off in the final boring of the tube. The weld is X-ray and magnetically inspected before acceptance.

Special Pantograph

To fill a need for a pantograph type of machine capable of carrying an automatic welding head for welding over circuitous paths, the heavy duty Pantograph shown in Fig. 27 was constructed. Being designed along massive lines, it is able to carry a number of cutting torches as well. When not in use for welding it is employed as a

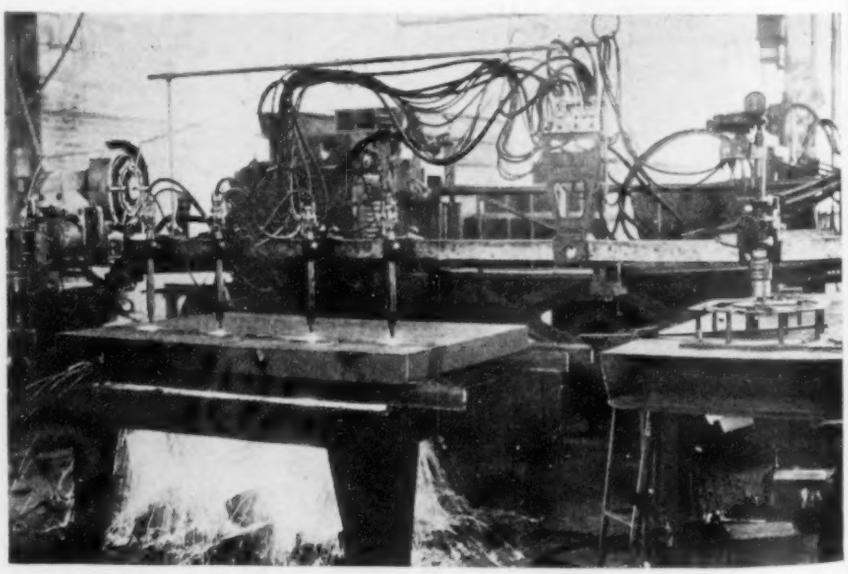


Fig. 28—Center Holes in Trunnion-Bearing Blocks Are Cut Out Before Profiling

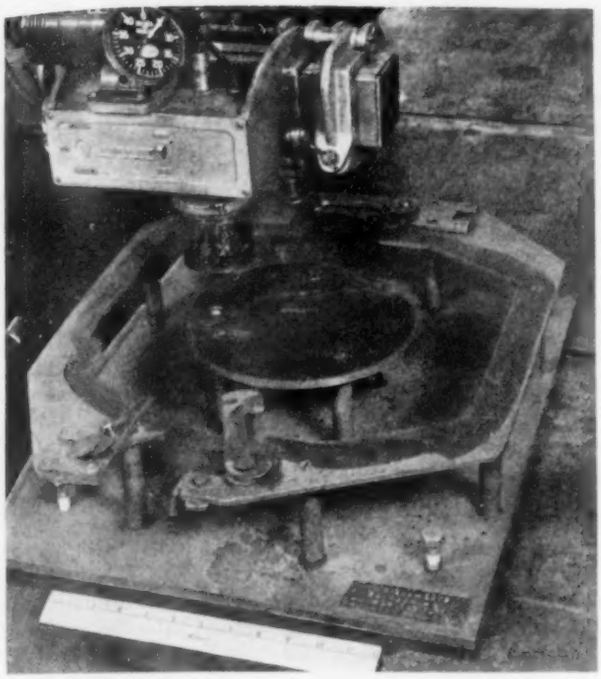


Fig. 29—Close-up of Steel Cam Used in Fig. 28, Showing Entrance and Exit Gates

standard cutting machine. In Fig. 28, for example, it is being used with four torches for cutting trunnion bearing blocks in multiple from $4^1/_2$-in. plate, using a magnetic tracer and steel cam. This cam is shown in Fig. 29, with movable entrance gates and a separate gate in the center for leading the tracer out from the lanced starting holes to the circular center opening which is cut first. These bearing blocks were formerly made by forging, but as the available forging facilities became inadequate we turned to flame cutting to insure a sufficient supply of the blocks.

Contour Beveling Attachment

Our strict requirements for uniformity throughout the length of a weld, as a means of controlling shrinkage, brought another cutting problem. Bevels of exact dimensions could easily be cut along straight lines or circular arcs, but no equipment was available for cutting an accurate bevel along irregular contours. While the need for such apparatus is normally not very great, we had sufficient use for it to warrant building an attachment to a standard Oxygraph for this purpose. As illustrated in Fig. 30, this attachment provides for rotational movement of a beveling torch through gears and shafts which transmit any degree of rotation of the tracing wheel post to the torch mounting post. Close study of this photo will show a spur gear mounted on the tracer post, meshed with a similar gear on a parallel shaft which, through housed bevel gears, drives a horizontal splined shaft on the torch bar. Keyed to this shaft at the torch mount is another set of bevel gears which transmits motion to the torch post. All pairs of gears are 1 to 1 ratio. Through this sytem, any change in direction of the tracing wheel is transmitted equally to the torch, keeping it always in line with the radius of any curve being beveled.

The torch mount is lined up to the work by means of a center point dropped from the hollow center of the post, lining up to the edge of the piece to be beveled. The torch is then adjusted to give the angle and depth of bevel desired. Fine control of the rate of manual turning around curves is provided by a long rod passed through the axis of the tracing wheel. The smoothness of cut obtained with this machine is shown in the finished trunnion-bearing support in the foreground in Fig. 30. Multiple torch beveling can be accomplished with this setup by simply mounting one or more additional torch mounts on the splined shaft.

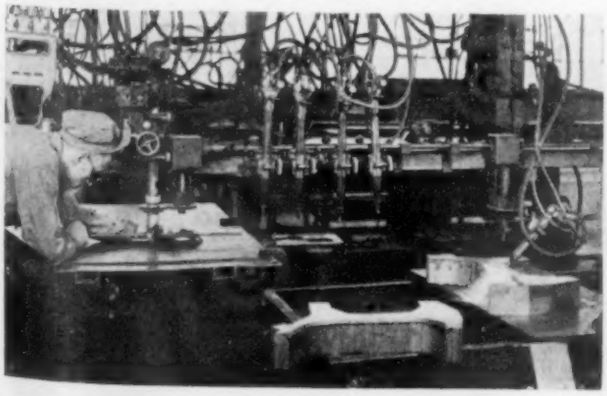


Fig. 30—Special Contour Beveling Attachment on Oxygraph Is Used Here to Cut a Bevel on an Irregular Curved Part. Note Smoothness of Cut on Finished Piece in Foreground

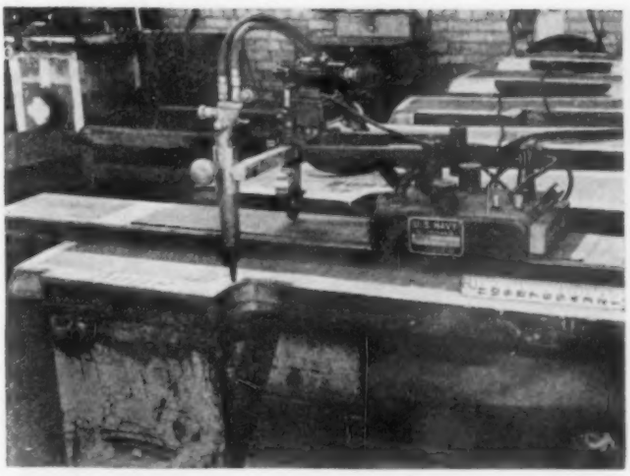


Fig. 31—Planograph Setup for Trimming Corner Radius of Gun Mount Slide After Welding. Cut Is Made Tangent to Machine Finish Line of Horizontal Edge at Right, for Tool Clearance

Fig. 32—Gas Cutting Setup for Trimming Rear Edge of Gun Mount Slide. Close Tolerances Are Met on These Cuts

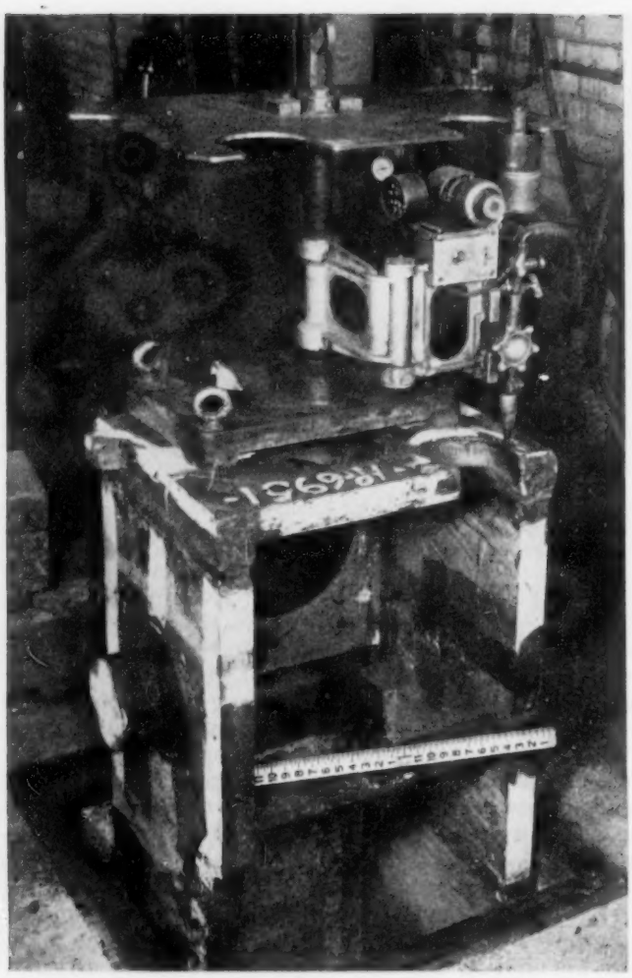


Fig. 33—Weldment Is Set in Pit for Convenience in Cutting Notch with Camograph. See Text for Description of Method of Locating Machine on Work

Finishing Cuts on Weldments

A great many man-hours of machining have been eliminated on the various subassemblies by judicious use of flame cutting. The practice mentioned previously of making these cuts on finished or semifinished weldments is one way that this is accomplished. This practice serves further as an excellent illustration of the flexibility of flame-cut and arc-welded fabrication. A few illustrative examples are given in the following.

In Fig. 31 a finished radius cut on a gun mount slide weldment is shown. This cut is made with a small Planograph prior to machining of the horizontal edge at the right of the curve. This simple cut saves a considerable number of man-hours of machining time formerly required. This cut not only shapes this area to finish dimension but it provides a tool relief cut for planing the adjacent plate edge and eliminates a separate machine setup.

A finished radius cut on another edge of this weldment is shown in Fig. 32. This cut, made with a Radiagraph on a 6 ft. radius at a bevel of 25° 30′, is made after welding because the center point of the radius is on a boss which is part of a forging welded into the assembly. Altogether three forgings and four flame-cut sections of plate are employed in this assembly. This radius bevel is cut slightly oversize and then hand ground to the finish line after final stress-relief annealing, a simple procedure which saves considerable time over the machining operation previously used.

The end section of the gun mount slide is also a forging, notched after welding by the Camograph shown in Fig. 33. Of interest in this setup is the method of locating the cutting machine on the workpiece. A template is first laid on the work, locating points for four prick punch marks. The Camograph is then set down on the work, and four pointed thumb screws threaded through the base of the machine are screwed down. This machine is joggled to bring the screw points into the punch indentations, thereby locating the machine in exact position for cutting the notch. The fixed cam on the ma-

Fig. 34—This Impressive Bank of Welding Positioners in the East End of the Welding Shop Indicates the Magnitude of the Production Layout for Fabricating Gun Mounts at Northern Ordnance

chine is designed to accommodate either right or left-hand gun mount slides.

Conclusion

As mentioned in the introduction to this paper, the foregoing discussion has been devoted largely to the more unusual applications of machine gas cutting, giving little attention to the more or less standard practices of single and multiple cutting which are likewise followed at Northern Ordnance.

Altogether, a total of more than a million cubic feet of oxygen per month is consumed in our normal cutting operations. Some idea of the magnitude of the fabrication operations may be gained from Fig. 34 which shows an almost endless battery of welding positioners in one bay of the fabricating shop.

Current Welding Literature

(*Continued from page 357*)

Electric Welding, Power Supply. Parallel Connection of Welders Provides Heavier Currents for Automatic Welding, I. B. Yates. Machy. (N. Y.), vol. 51, no. 6 (Feb. 1945), pp. 153–155.

Electric Welding, Power Supply. Resistance Welders—How Much Load? L. W. Clark. Elec. World, vol. 122, no. 26 (Dec. 23, 1944), pp. 64–65.

Electric Welding, Power Supply. Welding Load Extensions. Elec. Rev., vol. 135, no. 3486 (Sept. 15, 1944), pp. 367–368.

Electric Welding, Resistance, Aluminum. Welding Conditions and Mechanical Properties of Spot-Welded Aluminum Sheets, R. Irmann. Engrs.' Digest (American Edition), vol. 2, no. 2 (Feb. 1945), pp. 87–88.

Internal Combustion Engines, Maintenance and Repair. Method of Repairing Cracked Engine Blocks with Electric Bonder, L. E. Kunkler. Diesel Progress, vol. 10, no. 12 (Dec. 1944), pp. 76–77.

Jigs and Fixtures. Welding Fixtures, H. B. Pereira. Aircraft Production, vol. 6, no. 68 (June 1944), pp. 277–279, no. 69 (July 1944), pp. 352–354.

Machinery Manufacture. Fabrication of All-Welded-Steel Equipment and Its Application to Ceramic Industry, E. A. Hawk. Am. Cer. Soc.—Bul., vol. 24, no. 1 (Jan. 15, 1945), pp. 12–15.

Machinery Manufacture. Trends in Design of Weldments, E. J. Charlton. Machine Design, vol. 17, no. 1 (Jan. 1945), pp. 135–142, 192.

Magnesium Alloys. Flux for Flame Welding of Magnesium. Light Metals, vol. 8, no. 84 (Jan. 1945), pp. 7–8.

Metals Cleaning. Cleaning of Magnesium Surfaces for Satisfactory Spot Welds, F. Linville and M. Disotell. Product Eng., vol. 15, no. 12 (Dec. 1944), pp. 811–812.

Metals Finishing. Welding, Heat-Treating, Cleaning and Finishing. Am. Mach., vol. 89, no. 2 (Jan. 18, 1945) (Annual Review Number), pp. 309–327.

Metals, Hard Facing. Hints on Hard-Facing Procedure. Industry & Welding, vol. 17, no. 11 (Nov. 1944), pp. 46–47.

Motion Picture Machines. Soldering in Projection Room, H. B. Sellwood. Int. Projectionist, vol. 19, no. 11 (Nov. 1944), pp. 7–8, 24–26.

Natural Gas Pipe Lines. Highest Pressure Gas Line. Western Construction News, vol. 20, no. 1 (Jan. 1945), pp. 79–82.

Oxyacetylene Welding. Low-Temperature Welding. Aircraft Production, vol. 6, no. 71 (Sept. 1944), p. 446.

Oxyacetylene Welding Stainless Steel. Aircraft Production, vol. 6, no. 71 (Sept. 1944), p. 429.

Petroleum, Crude, Sulphur Removal. Refining Mixtures of Kansas-West Texas Crude Oil Proves Practicable, A. L. Foster and R. B. Tuttle. Oil & Gas J. (Jan. 20, 1945), pp. 37, 58–62.

Petroleum Refineries, Accident Prevention. Safety in Refinery, J. K. Skipton. Petroleum Engr., vol. 16, no. 4 (Jan. 1945), pp. 190, 192.

Petroleum Refineries. Adapting Old Equipment to New Uses, D. E. Evans and W. B. Meyer. Petroleum Refiner, vol. 23, no. 11 (Nov. 1944), pp. 455–457.

Photoelasticity. Study of Stress Distribution with Polarized Light, A. P. Maradudin. Petroleum Engr., vol. 16, no. 4 (Jan. 1945), pp. 103, 106, 108, 111, 114.

Pipe Line Welding, M. A. Hardie, Sr. Petroleum Engr., vol. 16, no. 3 (Dec. 1944), p. 78.

Pipe Lines, Construction. Use of Compressed Air in Swabbing Pipe Lines, F. H. Love. Petroleum Engr., vol. 16, no. 4 (Jan. 1945), pp. 141, 144.

Piston Rings, Hardening. Flame-Hardening Piston-Ring Grooves in Locomotive Pistons, S. Smith. Machy. (N. Y.), vol. 51, no. 6 (Feb. 1945), p. 161.

Railroad Materials, Conservation. Bridge and Building Section. Ry. Eng. & Maintenance, vol. 40, no. 11 (Nov. 1944), pp. 1025–1048.

Rails, Oxyacetylene Cutting. Southern Crops Rails with Special Torch Assembly. Ry. Eng. & Maintenance, vol. 40, no. 11 (Nov. 1944), pp. 1023–1024.

Sheet Metal Working, Handbooks. Sheet Metal, Theory and Practice, J. C. Butler, drawings by L. O. Genereux. John Wiley & Sons, New York; Chapman & Hall, Ltd., London, 1944. 173 pp., illus., diagrs., charts, tables, $3.00.

Shipbuilding, Great Britain. British Wartime Shipbuilding in Retrospect, V. D. Wethered. Mar. Engr., vol. 68, no. 810 (Jan. 1945), pp. 22–26, 56.

Shipbuilding, Great Britain. Technical Progress in Shipbuilding During 1944. Shipbldr. & Mar. Engine-Bldr., vol. 52, no. 429 (Jan. 1945), pp. 2–9.

Shipbuilding. Some Recent Technical Developments in Naval Construction, S. V. Goodall. North East Coast Instn. Engrs. & Shipbldrs.—Trans., vol. 61, pt. 1 (Nov. 1944), pp. 27–50.

Shipbuilding. Production Welding of "Extruded" Ships, F. Waldo. Mar. Eng. & Shipg. Rev., vol. 50, no. 1 (Jan. 1945), pp. 170–177.

Shipbuilding. Welding Sectionally Cast Stern Frames. Iron Age, vol. 154, no. 26 (Dec. 28, 1944), pp. 52–55.

Soldering. Soft Soldering, C. W. Hart. Min. J. (Lond.), vol. 214, no. 5710 (Jan. 27, 1945), pp. 53–55.

Steam Power Plants, Maintenance and Repair. Maintenance of Mechanical Power-Plant Equipment, A. Iddles. Elec. Light & Power, vol. 22, no. 11 (Nov. 1944), pp. 62–65.

Steel, Aluminum Coating. Aluminized Steel. Aircraft Production, vol. 6, no. 72 (Oct. 1944), pp. 505–506.

Tubes, Welded Steel. Flash Welding SAE 4130 Steel Tubing, W. Pestrak and W. W. Ackerman. Iron Age, vol. 155, no. 4 (Jan. 25, 1945), pp. 46–49.

Tubes, Welded Steel. Some Applications of Welded Aircraft Tubing, J. S. Adelson and P. Hill. Steel Processing, vol. 30, no. 12 (Dec. 1944), pp. 806–808, 816.

Water Heaters, Gas. Building A. O. Smith's Permaglas Water Heater. Gas, vol. 20, no. 12 (Dec. 1944), pp. 20–21.

Welded Steel Structures. How Arc Welding Affects Design of Machines and Structures, W. J. Conley. Can. Machy., vol. 55, no. 12 (Dec. 1944), pp. 390, 394, 396, 398.

Welding Shops, Floating. Diesel-Powered Welding Barge Speeds Shipyard Operations. Power, vol. 89, no. 1 (Jan. 1945), pp. 30–31.

Welds, Testing. Effect of Time of Storage on Ductility of Welded Test Specimens, C. E. Jackson and G. G. Luther. Am. Inst. Min. & Met.—Tech. Publ., no. 1772 for meeting Oct. 1944, 8 pp. (Metals Technology, Jan. 1945).

Helium-Shielded Arc Welding*

By L. V. Barber† and H. S. Kennedy‡

IF IN the postwar era lighter metals like aluminum and magnesium are substituted for steel in automobile bodies, railroad cars, farming implements, machinery, portable tools and other products for home and industry, the technique of electric arc welding may advance to a point far beyond that reached in the present war period.

Developed during World War I of 1914–17, the art of electric welding first was considered little more than a "repair" tool and was used widely in reconditioning Army trucks and other vehicles and in repairing sabotaged enemy vessels seized by the Navy. After the war, industry slowly accepted electric arc welding as a "tool of production," but not until the second World War was the real value of this art in accelerating production fully demonstrated.

Welded Liberty ships, Victory freighters, Sherman tanks, airplane fuselages and housings and other parts of machine tools and Diesel engines represent only a small fraction of the wartime application of the welder's torch, which has speeded output, reduced costs and turned out a lighter, stronger finished product.

One of the most important factors contributing to the greatly expanded use of magnesium and its alloys in industry, particularly aircraft, is the development of helium-shielded arc welding. Because of the affinity of magnesium for oxygen and nitrogen, especially at high temperatures, welding of this metal and its alloys was impossible before the process of welding in an inert-gas atmosphere was introduced.

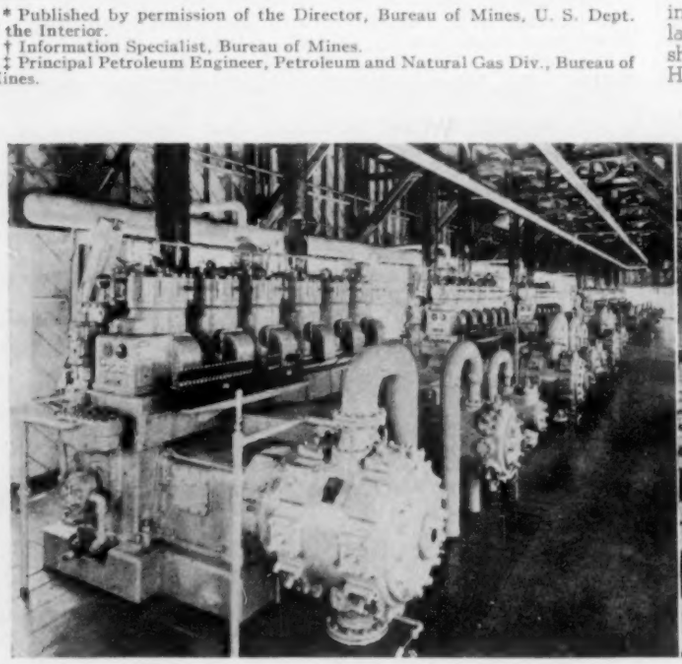
In this operation, an inert gas, such as helium, fed

Courtesy Bur. of Mines, U. S. Dept. of the Interior

With helium produced only by the Bureau of Mines, the heliarc welding process has made possible the welding of magnesium and its alloys, now widely used in the construction of airplanes and other products. Here, a silver-white sheet of this inflammable, lightweight metal is being welded manually with helium acting as a shield, holding off oxygen in the air and preventing the metal from bursting into flame. Chains hold the sheet in place as the welder manipulates his hand torch. The name "heliarc," as applied to helium-shielded arc welding, is the patent of The Northrop Aircraft Corp., Hawthorne, Calif.

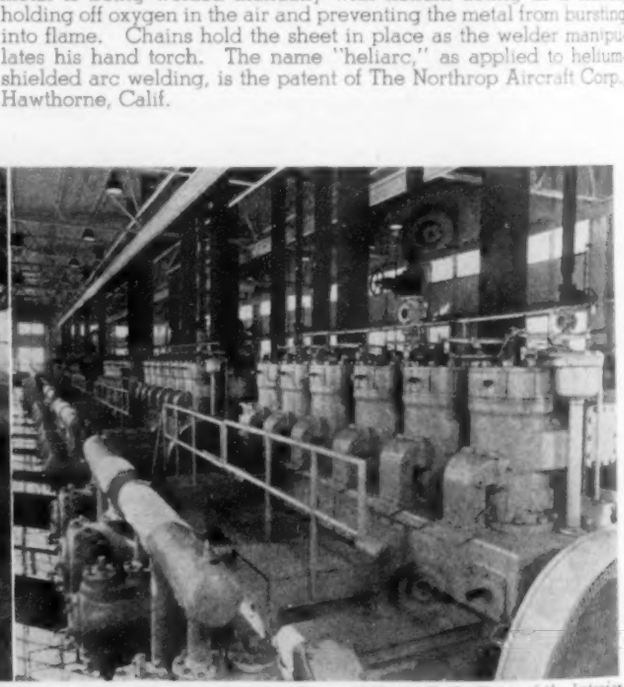
* Published by permission of the Director, Bureau of Mines, U. S. Dept. of the Interior.

† Information Specialist, Bureau of Mines.
‡ Principal Petroleum Engineer, Petroleum and Natural Gas Div., Bureau of Mines.



Interior View of the Compressor Building at the Otis, Kan., Helium Plant

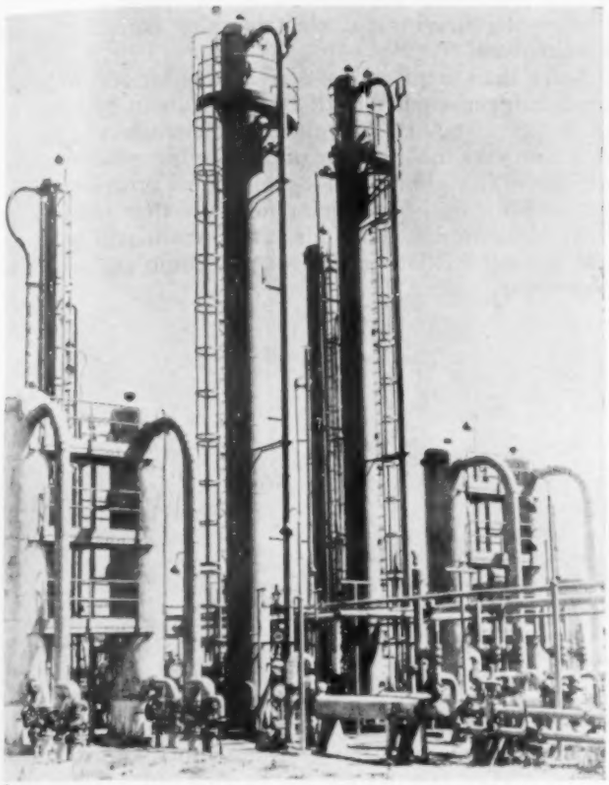
This is one of the newest of five helium plants which the Bureau has operated during the War to provide helium for military purposes and for industrial and scientific uses.



Courtesy Bur. of Mines, U. S. Dept. of the Interior

Interior View of the Compressor Building at the Exell Helium Plant of the Bureau of Mines at Exell, Tex.

This plant is one of five operated by the Bureau to provide helium for military purposes and for industrial and scientific uses.



Courtesy Bur. of Mines, U. S. Dept. of the Interior

Exterior View of the Carbon Dioxide Removal Unit of the Bureau of Mines Exell Helium Plant at Exell, Tex.

through a nozzle that surrounds the tungsten or carbon electrode, completely envelops the lower end of the electrode and the work directly beneath it, shields the molten metal from the normal atmosphere, and prevents the formation of injurious oxides, nitrides or other compounds that would impair the strength of the weld.

In this process—readily adaptable to automatic as well as manual operations—coated welding rods and fluxes are not required for fabricating magnesium and its alloys, but fluxes still are used in welding aluminum. Current experiments, many involving confidential Government and private research, are expected to solve some remaining problems in welding aluminum.

Helium-shielded arc welding of magnesium and its alloys is a d.-c. process utilizing standard types of d.-c. welding machines, approximately 150-amp. capacity for lighter gages up to about $^3/_{16}$ in. and about 300 amp. capacity for heavier gages or for high-speed welding. Because straight polarity results in an unstable arc and excessive "spatter," magnesium always is welded with reverse polarity; that is, with the electrode positive and the work negative.

Commercial helium of 98% purity, as supplied by the Federal Bureau of Mines, sole producer of helium, to various commercial dealers in compressed gases, is pure enough to give satisfactory welding results. Excesses of impurities have very pronounced undesirable effects on welds. Water will break down in the arc to form hydrogen and oxygen. The hydrogen, being readily absorbed by the molten metal, produces bad porosity, while the oxygen reacts to form magnesium oxide.

Although helium-shielded arc welding has had its greatest development and improvement in the aircraft industry, postwar fabricators of light metals foresee continued progress in the process, which already has demonstrated its efficiency, low cost and performance in one spectacular wartime field. The increase in the field of application depends largely on the expansion in the structural use of magnesium and aluminum alloys.

One large aircraft manufacturer using considerable helium both in automatic and in manual welding has estimated that a cylinder of helium, containing approximately 200 cu. ft. of the gas, will last 48 to 52 welding hours in an automatic operation on $^1/_8$-in.-gage magnesium alloy at a rate of 48 in. per minute.

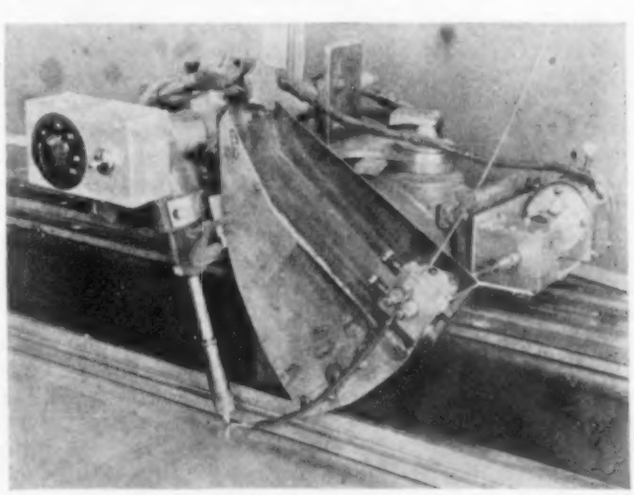
The Bureau of Mines now sends helium to Army and Navy depots in tank-car lots, about 200,000 cu. ft. at a time. Less than 100 of these tank cars are available at present and virtually all are in continuous military service.

No commercial gas distributor has acquired a sufficient volume of business to warrant tank-car deliveries, but it is highly probable that in the postwar expansion of the applications of helium, tank-car orders to commercial outlets may become common. Although the Bureau controls the entire production of helium, the distribution of the gas (other than that consigned to Government agencies, including the Army, the Navy and the Weather Bureau), is handled by commercial distributors of compressed gases, who now have supplies in cylinders available in the principal cities of the country.

Not fully developed is the application of helium-shielded arc welding to stainless steel. However, another aircraft manufacturer, adopting this method in fabricating stainless-steel manifold exhaust collectors, anticipates a 30% increase in production and a $43,000 per year reduction of costs in one department alone.

The large savings result from the speed and high quality obtained with helium-shielded arc welding, as well as from elimination of the need for flux and the alcohol and shellac required for mixing the flux.

The direction of a low-velocity stream of helium gas to the arc tends to concentrate the heat in the immediate vicinity of the arc and has a beneficial effect on the de-



Courtesy Bur. of Mines, U.S. Dept. of the Interior

Northrop Automatic Heliarc Welder—Note the Gear Box Driving Mechanism—1 Mg. Hold-Down Removed

Speeding up the fabrication of magnesium and its alloys, now widely used in the construction of airplanes and other products, automatic heliarc welding equipment effects savings in man-hours and money. Helium produced only by the Bureau of Mines acts as a shield, holding off oxygen of the air and preventing this inflammable metal from bursting into flame. This automatic heliarc welder, with one "hold-down" removed from the driving mechanism, shows the torch and rod in welding position. The name "heliarc," as applied to helium-shielded arc welding, is the patent of The Northrop Aircraft Corp., Hawthorne, Calif.

posited weld metal. Because the heat does not travel a great distance from the weld area, warpage and subsequent hand forming, after the weld cools, are eliminated. By methods formerly employed, warpage of the stainless steel was so prevalent that hand forming was required on almost all pieces welded.

In testing stainless steel 90° angle welds, operators have far surpassed Army specifications, which require a 90° bend, whereas the tests have produced bends of 270° without fracture. Armor plate also has been welded successfully with uncoated electrodes, eliminating the necessity of removing the electrode slag normal to coated welding rods.

More than a quarter of a million cubic feet of helium are consigned each month by the Bureau of Mines for arc welding and other commercial, scientific and medical uses, and experiments now under way promise its further usefulness in welding and metallurgical processes. With 5 plants capable of producing far more than military and other Government demands, the Bureau still has available several million cubic feet of helium per month for nonmilitary uses.

Fire Hazard Aboard Ship

By Guy Amodeo*

THE fire hazard in shipbuilding and repair is greater than every today. Our modern ships, combining fuel oil, gasoline, munitions, plus welding and burning, provide a serious problem in fire prevention and fire fighting, which cannot be ignored in any shipyard.

The first approach to the problem is the education of the yard personnel as to the danger involved. Welders and burners who are the cause of many fires must be impressed that fire prevention is one of their prime duties. Every welding operator and burner must, before starting his job, be certain that no unsafe condition exists. He must check the other side of the bulkhead or deck he is working on and be certain that the other side is not a fuel tank, powder magazine, paint or medical locker or contains clothes or other inflammables or explosives. This is his responsibility and must be checked personally, taking no one's word for it that the job is safe, even though the someone be the captain of the ship. I know of one case where an officer assured me that a job was safe. Upon checking, on my insistence (he didn't have the keys handy), it turned out to be a powder magazine loaded with powder. A few minutes of welding on that bulkhead, and the ship, with perhaps several others tied alongside, would have been blown sky-high.

On every ship, with the exception of ships under construction, every welding operator and burner must be supplied with an assistant or "fire-watcher." The fire-watcher is furnished with CO_2 fire extinguisher, the use of which has been explained to him. It is his job to assist the welding operator in preventing and putting out any fire that may start, before it can become serious. Ninety per cent of the time, the fire started can be extinguished without the use of the extinguisher. In working close to electric cables, to prevent damage, the cables are wrapped with asbestos cloth. However, the responsibility must rest with the mechanic. He cannot afford to accept the fire-watcher's statement that the other side is safe. The assistant is placed at the discretion of the welding operator or burner, either alongside of him, on the other side of the job, or below. On some jobs two or more fire-watchers should be used.

Fire marshals must be appointed to see to it that all fire-prevention regulations are carried out. These must be competent, intelligent men, and paid at least the mechanic's rate of pay. Their job is to make the rounds of the ship and see that no unsafe condition exists. They must make certain that no welding or burning is being done close to any fuel tank being cleaned, while the ship is being fueled or fuel removed or while munitions are loaded or unloaded. They must okay as safe any part of the ship where work is to be done.

A fire-watcher should be established on shipboard or on the dock. Here the welding operator and burners pick up their fire-watchers and inform the Chief Fire Warden where their job is and obtain his okay. The station contains fire-fighting and rescue equipment including smoke masks and special safety clothes for rescue workers.

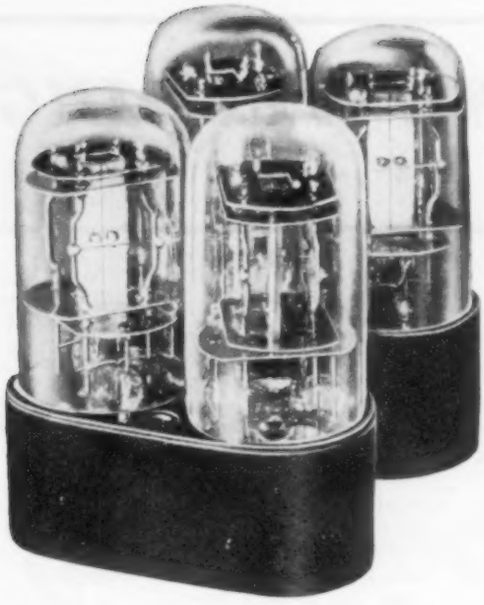
On large ships, special fire rescue boxes are placed. These can be wood or metal boxes about 3 x 3 x 6 ft., painted red. The boxes are padlocked and the key placed in a small glass-covered box fastened with the lock where it may be obtained by smashing the glass. The box should contain asbestos gloves, No. 2 welding goggles, fire extinguisher (CO_2 and water types), pails of sand, safety belts, a coil of rope, sledge, bolt cutter, insulated wire cutter, ax, shovels, etc.

Any welding on tanks containing oil must be done only under the direct supervision of highly trained personnel, with men trained in fighting oil fires "standing by" with the proper fire-fighting equipment.

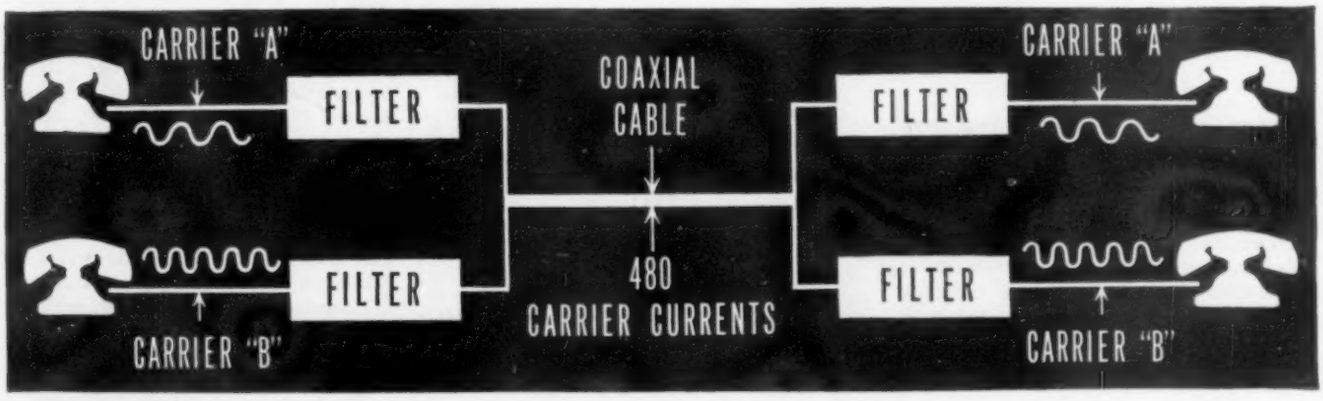
Under no circumstances must welding or burning be allowed in or around any tank that has contained fuel until the tank has been cleaned, tested and certified as free from fumes. No welding or burning must be allowed in powder or shell magazines until the contents have been removed. Extreme caution must be used around depth charges and torpedoes on decks. Welding operators must fasten their welding leads overhead, out of the way. A worn spot in the cable, coming in contact with the deck or bulkhead, can make a spark and cause a ship to blow out of the water with great loss of life.

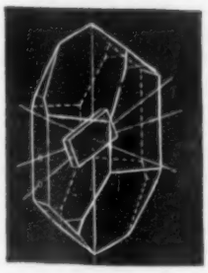
When oil and munitions are involved, an ounce of prevention is worth more than a ton of CO_2. Remember, if the ship blows up, you're blowing up with it!

* Welder Arc Elec. 1/c, U. S. Navy Yard.



Crystal gateways for your voice





Four hundred and eighty telephone conversations over a coaxial cable was one of the last peacetime achievements of communication research in Bell Telephone Laboratories. In this multi-channel telephone system, each conversation is transported by its own high-frequency carrier current. At each end of the line are crystal gateways; each opens in response to its own particular "carrier" with the message it transports. In telephone terminology, these gateways are filters.

The ultra-selective characteristic of these filters is made possible by piezo-electric quartz plates, cut in a special manner from the mother crystal, and mounted in vacuum. Each set of plates is precisely adjusted so that the filter responds only to the frequency of its assigned channel, rejecting all others. In the coaxial terminal equipment, such crystal gates sort out messages for delivery to their four hundred and eighty individual destinations.

In recent years, Bell Telephone Laboratories research has provided the Armed Forces with many types of electrical equipment in which frequency is controlled by quartz crystals. Notable is the tank radio set which enables a tank crew to communicate over any one of 80 different transmission frequency channels by simply plugging in the appropriate crystal. The future holds rich possibilities for the use of quartz crystals in Bell System telephone service.

BELL TELEPHONE LABORATORIES

Exploring and inventing, devising and perfecting for our Armed Forces at war and for continued improvements and economies in telephone service.

THE AMERICAN WELDING SOCIETY

ACTIVITIES – RELATED EVENTS

NOTICE TO MEMBERS

Several libraries have requested assistance in securing bound volumes of THE WELDING JOURNAL. Volumes for the following years are missing: 1935, 1936 and 1939.

The Society will pay $5.00 for each bound volume of these years received in good condition.

1945 A.W.S. DIRECTORY

In order to conserve paper the new 1945 A.W.S. Membership Directory, now available, will be only sent to those requesting a copy. There is no charge to members of the Society. Address request to: AMERICAN WELDING SOCIETY, 33 West 39th St., New York 18, N. Y.

AWARD PROGRAM FOR TEXTBOOKS IN MODERN DESIGN

A project in the form of an Award Program to encourage the preparation and publication of textbooks, one on machine design and another on structural design for fabrication by all processes, including welding, is announced by The James F. Lincoln Arc Welding Foundation, Cleveland, Ohio.

Said to be an important contribution toward stimulating instruction and study for engineering undergraduates in these important fields, the program will substantially reduce the usual delay between process developments in industry and the treatment of these new developments in textbook form. This is particularly significant in view of the many new applications and improvements in welding design techniques that have resulted from the intensified activity and advancements in arc welding during the past 3 wartime years. Thus, the prime effect of the plan will be to render a service to engineering colleges and to the industries which employ their graduates by making this pertinent and timely information more conveniently available and comprehensible.

The Committee on Rules is comprised of the following Deans of Engineering: Ivan C. Crawford, Dean, College of Engineering, University of Michigan; H: P. Hammond, Dean, School of Engineering, Pennsylvania State College; S. C. Hollister, Dean, College of Engineering, Cornell University; F. Ellis Johnson, Dean, College of Engineering, University of Wisconsin; Webster N. Jones, Director, College of Engineering, Carnegie Institute of Technology; S. C. Lind, Dean, Institute of Technology, University of Minnesota; C. E. MacQuigg, Dean, College of Engineering, Ohio State University; E. J. Streubel, Dean, Polytechnic Institute of Brooklyn; E. E. Dreese, Chairman, Department of Electrical Engineering, Ohio State University.

The Foundation's new project, known as "The $20,000 Award Program for Textbooks Covering Machine and Structural Design for Modern Processes" is made eligible to any person in the teaching profession, in industry, or engaged in private consultation. A manuscript may be submitted jointly by two or more persons. No one person can participate in the writing of more than one manuscript in each class—Machine Design and Structural Design.

The awards in the program are divided into two classes: Class A, Machine Design; and class B, Structural Design. There are three awards in each class as follows:

Class A—Machine Design: First Award, $5000; Second Award, $3000; Third Award, $2000.

Class B—Structural Design: First Award, $5000; Second Award, $3000; Third Award, $2000.

If the Jury of Award so recommends, the First Award papers in each class of participants will be published by a recognized publisher of engineering textbooks and the authors will receive royalties from their textbooks when sold in book form.

Papers will be judged by a Jury of Award drawn from appropriate branches and institutions of engineering education. Selection of the jury will be under the direction of the Chairman of the Jury of Award, Doctor E. E. Dreese, Ohio State University, Columbus, Ohio.

Judgment to be made by the Jury of Award in rating the merits of the manuscripts will be based on the factors of (*a*) educational value and utility, (*b*) excellence and modernity of content, (*c*) adequacy in coverage of designing for welding, (*d*) clarity and logic of arrangement, (*e*) completeness and thoroughness of treatment consistent with proper length for collegiate use, (*f*) proper balance of topics in accordance with importance and (*g*) indications of future progress in the given field.

While the purpose of this Award Program is to encourage the writing of the most modern texts in machine design and structural design, revisions of existing textbooks in these fields are eligible.

The subject matter of the manuscripts is to be suitable for collegiate engineering textbooks in Machine Design and Structural Design, with the objective of producing the most modern textbooks in these fields. Fabrication methods, including welding, are to be treated as elements in design practice so as to provide a well-balanced treatment.

Welded design may be treated as a separate subject in a chapter or chapters devoted to that purpose, or it may be treated appropriately throughout the textbook. It is to be noted especially that the subject matter dealing with Machine Design and Structural Design is to be up-to-date as to design principles, while at the same time suitable for basic textbooks for undergraduate engineering students. Undue or unwarranted emphasis on any special fabricating or shop process is to be avoided. The purpose is to produce a well-balanced text of greatest utility as a basic engineering textbook.

The James F. Lincoln Arc Welding Foundation has conducted numerous award programs in the past. Among these have been the General Industrial Award Program, and the Industrial Progress Award Program, which have been participated in by business executives etc.

Another recent program of The Foundation was the Undergraduate Award and Scholarship Program, participated in by engineering undergraduate students.

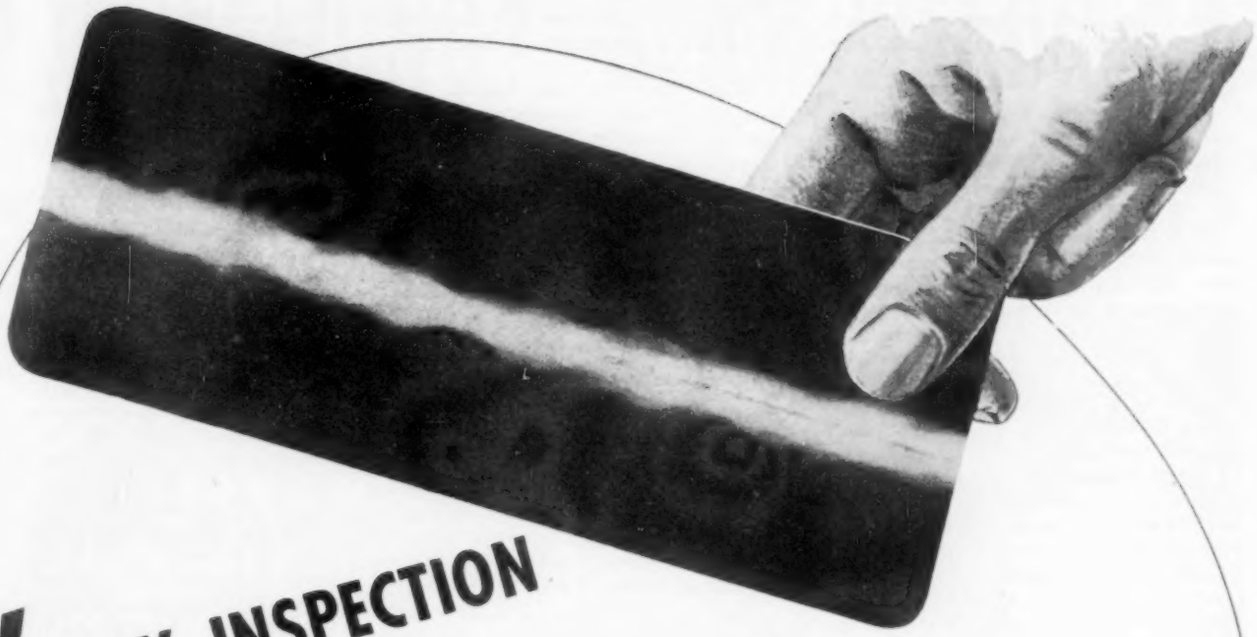
The Foundation has also been active in establishing special book collections in engineering schools.

The Foundation, which was created in 1936 in honor of James F. Lincoln, president of The Lincoln Electric Company, Cleveland, Ohio, has also published books such as "Arc Welding in Design, Manufacture and Construction," "Studies in Arc Welding" and "Maintenance Arc Welding."

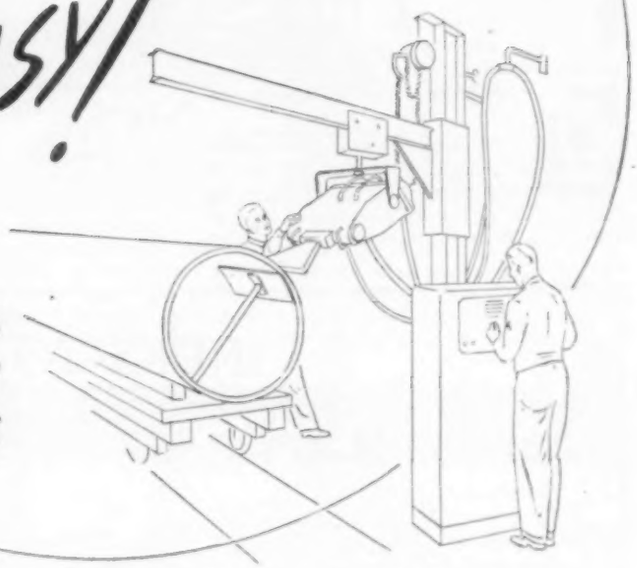
Further details of this new Award Program for textbooks, which closes May 15, 1946, may be ootained by addressing The Secretary, The James F. Lincoln Arc Welding Foundation, Cleveland 1, Ohio.

1944 BOOK OF A.S.T.M. STANDARDS

The complete new 1944 Book of A.S.T.M. Standards, issued in three parts contains in their latest approved form all of the Society's widely used specifications and tests for materials. A most important book in connection with the production, purchase and use of materials, the latest edition has 1235 specifications and standard methods which cover more than 6000 pages.



X-RAY INSPECTION made SURPRISINGLY EASY!



WITH KELEKET'S NEW 250 KV X-RAY UNIT

For detecting welding defects—porosity, incomplete fusion, inclusions, cracks, etc.—*before* they can cause trouble, this KELEKET X-ray unit combines ample power with simplicity of operation that is almost unbelievable! It enables you to train an employee in the shortest possible time to produce radiographs that are uniformly good and easy to read.

The control panel has only half as many controls as conventional equipment of similar capacity. With so few controls to manipulate, the operator can concentrate thoroughly on the actual radiographic problem.

Chances for human error are reduced to the minimum by numerous automatic features, many patented and exclusively KELEKET. Simple push buttons control milliamperage and kilovoltage. Pilot lights automatically flash warning signals to prevent overload or other injury. Should the power exceed the tube rating, it is automatically shut off. The unit is self-protected against surges in line current, and adjustments for voltage variations can be made while the machine is in operation.

The entire unit, completely shockproof and rayproof, is very compact. Transformers and oil cooler are self-contained in the tubehead which can be mounted on a jib crane or hand truck.

Learn how this new KELEKET 250 KV unit can help reduce weld failures in your plant. Ask the KELEKET representative in your city or write us direct.

KELLEY-KOETT X-RAY MFG. COMPANY
2184 WEST FOURTH ST., COVINGTON, KY.

KELEKET—THE FINEST TRADITION IN X-RAY

All specifications, whether formal standards or tentative are given. The Book is issued in three parts, the divisions being as follows:

Part I, Metals.—Ferrous and nonferrous metals (all A and B and some E serial designations) except methods of chemical analysis. General testing methods (E serial designations).

Part II, Nonmetallic Materials—Constructional.—Cementitious materials, concrete and aggregates, masonry building units, ceramics, pipe and tile, thermal insulating materials (all C serial designations). Wood and wood preservatives, paints, varnishes and lacquers, road materials, waterproofing and roofing materials, soils (certain D serial designations). General testing methods, thermometers (E serial designations).

Part III, Nonmetallic Materials—General.—Fuels, petroleum products, electrical insulating materials, rubber, textiles, soaps and detergents, paper, plastics, water (remainder of D serial designations). General testing methods, thermometers (E serial designations).

An innovation in this 1944 Book is the inclusion of all emergency standards and emergency alternate provisions which have been widely used to expedite production and procurement of important materials.

Each part of the 1944 Book has a complete subject index (from 36 to 44 pages). There are two extensive tables of contents, the first lists all standards under general materials headings; the second according to the serial designations of the standards. These features facilitate reference to any subjects covered.

Some idea of the large increase in the size of the Books is indicated from comparative figures for 1939, 1942 and 1944. (Publication of the Books has been triennial, until this latest edition, a full year ahead of normal issuance because of heavy demands for the 1942 book, much of it occasioned by the war effort.)

1939—866 Standards—3700 pages
1942—1104 Standards*—4900 pages
1944—1235 Standards*—6030 pages

* Not including emergency standards, in 1942, 19; 1944, 25.

Supplements, Detailed Index

To keep the Books up to date, a supplement will be issued to *each* part late in 1945. As a service with the 1944 Book of Standards there is a complete 200-page Index to Standards, which is furnished without additional charge and a copy accompanies the purchase of each part or complete set.

Sales Prices—Including Supplements (Cloth Binding*)

	Any One Part	Any Two Parts	All Three Parts
1944 Book of Standards and Tentative Standards, Parts I, II, III			
List prices	$10.00	$20.00	$30.00
Supplement for 1945			
List prices	4.00	8.00	12.00

* For half-leather binding add $1.00 for each part and Supplement Part.

Copies may be obtained from the American Society for Testing Materials, 260 South Broad St., Philadelphia, Pa.

MASS PRODUCTION OF ALUMINUM BRIDGE PARTS

A process of automatic carbon arc welding, which was perfected by The Lincoln Electric Co., Cleveland, Ohio, is said to be the only method by which vitally needed aluminum parts for military bridges can be fabricated on a mass scale.

The welding equipment used for this high-production project is a Lincoln product known as the "Electronic Tornado." It is a process of shielded carbon arc welding which has already established itself as the standard procedure where volume output is called for in fabricating various industrial and war essentials such as tanks, boilers, piping, automotive parts and various machinery items.

Now, the process has been so successfully applied to the production of aluminum parts for special military bridge structures that 35 engineers representing 14 different firms from 9 states have been attending a special course on the application of the "Electronic Tornado" in the automatic welding of aluminum at the Lincoln plant. A study of manual shielded arc welding of this metal is also included in the course which is being conducted by Lincoln welding engineers and consultants.

INDEX TO ADVERTISERS

Air Reduction Sales Co.....Outside back cover
American Brass Company..... 401
American Chain & Cable Company, Inc..... 391
American Optical Co..... 395
American Welding Society..... 428
Anti-Borax Compound Company..... 400
Arcos Corp.....Inside front cover

Bastian-Blessing Co..... 392
Bell Telephone System..... 381

Carnegie-Illinois Steel Corp..... 397
Champion Rivet Company..... 399
Chicago Bridge & Iron Co..... 338
Chicago Eye Shield Co..... 419
Chicago Steel & Wire Co..... 394

Eisler Engineering Co..... 394
Electroloy Co., Inc..... 402

General Electric Co..... 385
General Electric X-Ray Corp..... 409
Glenn-Roberts Company..... 421

Harworth Mfg. Co..... 423
Hobart Brothers Co..... 323

International Nickel Co..... 364

Kelley-Koett Mfg. Company..... 383

Lepel High Frequency Labs..... 403

The Lincoln Electric Co.....388 and 389
The Linde Air Products Company..... 325

Machlett Laboratories, Inc..... 407
Magnaflux Corporation..... 427
P. R. Mallory & Co., Inc..... 417
The McKay Company..... 424
Metal & Thermit Corporation..... 405
The Midland Paint & Varnish Co..... 392

National Carbide Corporation..... 396
National Time & Signal Corp..... 358
Nelson Specialty Welding Equipment Corp... 411

Oakite Products, Inc..... 398

Page Steel & Wire Division..... 391
Progressive Welder Co..... 415

The Reid-Avery Company..... 413
Resistance Welder Mfrs. Association..... 430

Sciaky Bros..... 393
Shawinigan Products Corp..... 400
The Sight Feed Generator Company..... 386
A. O. Smith Corporation..... 425
Square D Company..... 387

Thermacote Co..... 390

Una Welding, Inc..... 426
Union Carbide and Carbon Corp..... 395
United States Steel..... 397
United Welding Company..... 398

Victor Equipment Co..... 326

Westinghouse Elec. & Mfg. Co....Inside back cover

SPOT WELDING? SEAM WELDING?

Here's a NEW Method of Keeping Weld Current Constant . . . AUTOMATICALLY

In this application, the G-E current-regulating compensator enables the operator to use the press and gun welder interchangeably, when welding materials of the same thickness, without making any additional adjustments—even though the resistance of the portable secondary cable for the gun welder is appreciably greater than the resistance of the secondary circuit of the press welder.

G-E CURRENT-REGULATING COMPENSATOR

THIS new current-regulating compensator will *automatically* correct for line-voltage variations and power factor, or impedance, changes, and will do it within three cycles. It will hold the current within plus or minus 2 per cent of normal, where changes would cause the unregulated current to vary as much as plus or minus 20 per cent.

You Get These 5 Other Advantages, Too

1. *Flexibility of Operation*—The same control settings can be used, and consistent results can be obtained when: (a) using a press-type spot welder; (b) using a gun welder connected to the same welding transformer; or (c) welding magnetic materials with a press- or gun-type welder with the material in or out of the throat of the welding machine.

2. *Improved Quality*—Without the use of this control, the introduction of material in the throat of the welder would cause unsatisfactory welds because of the changes in welding current. It would do so in many applications, such as in the welding of barrels, propeller blades, or large steel assemblies.

3. *Seldom Needs Adjustment*—After the operator has once determined the proper settings for an operation, no further adjustments are necessary—the current-regulating compensator takes care of variations.

4. *Electronic*—Electronic tubes and circuits insure fast operation, good results, long service, low maintenance.

5. *Correlated Design*—This current-regulating compensator is designed for use only with G-E resistance-welding controls which include heat control by the phase-shift method. Complete interconnection diagrams are supplied to assist in installing this equipment.

Want More Information?

Bulletin GEA-4220, well-illustrated, describes all the features that make this new current-regulating compensator the solution of many resistance-welding problems. Ask our local office for a copy today. *General Electric Company, Schenectady 5, N. Y.*

Buy all the BONDS you can—
and keep all you buy

GENERAL ELECTRIC

645-30-8960

RESISTANCE-WELDING CONTROL

MAINTENANCE WELDING

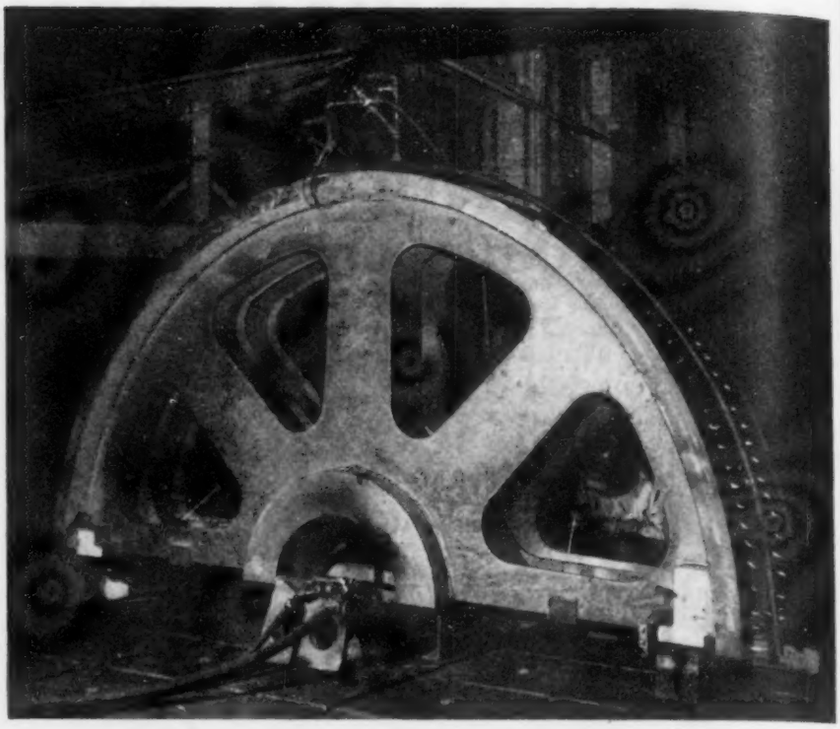
From Eutectic Welding Alloys Co., 40 North St., New York, comes the announcement that they have just brought out a six-page folder on their *low temperature* welding rods.

SUPPORTING COMPANIES

Tide Water Associated Oil Company, Bayonne, N. J., producers and refiners of crude oil and manufacturers and marketers of Veedol motor oils, Flying "A" gasolines, Tycol industrial lubricants and other petroleum products. At its Bayonne, N. J., refinery it manufacturers high octane aviation gasolines for the armed forces in its Houdry unit and in its new Thermofor catalytic cracking unit. Also has extensive refineries and other modern equipment in the Mid-West and on the Pacific coast.

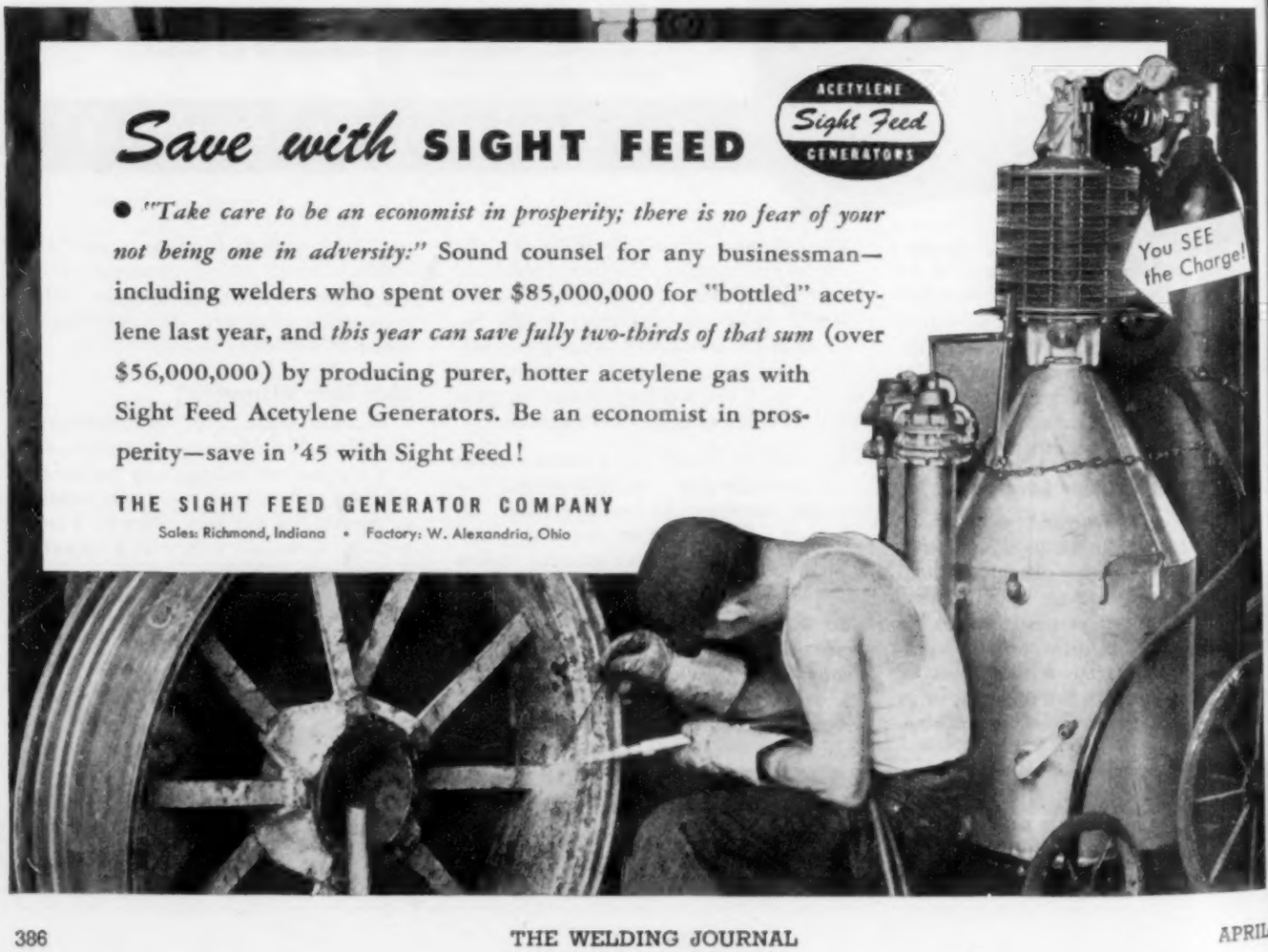
Hydraulic Supply Manufacturing Co.,* Seattle, Wash., designers, fabricators and erectors of steel products, hydraulic mining equipment, steel pipe, tanks and stacks, penstocks, syphons and flumes, steel irrigation and dredge pipe, corrugated metal culvert pipe. Now engaged in the manufacture of welded steel parts for Aircraft Carriers, Cargo Ships, and Destroyers, besides manufacturing pipe, structural steel weldments, chain, etc., for Army, Navy and Aircraft use. Main peacetime item is light gage mining pipe. Also make practically everything from welded steel, stainless steel, Everdur or nickel steel.

* Sustaining member.



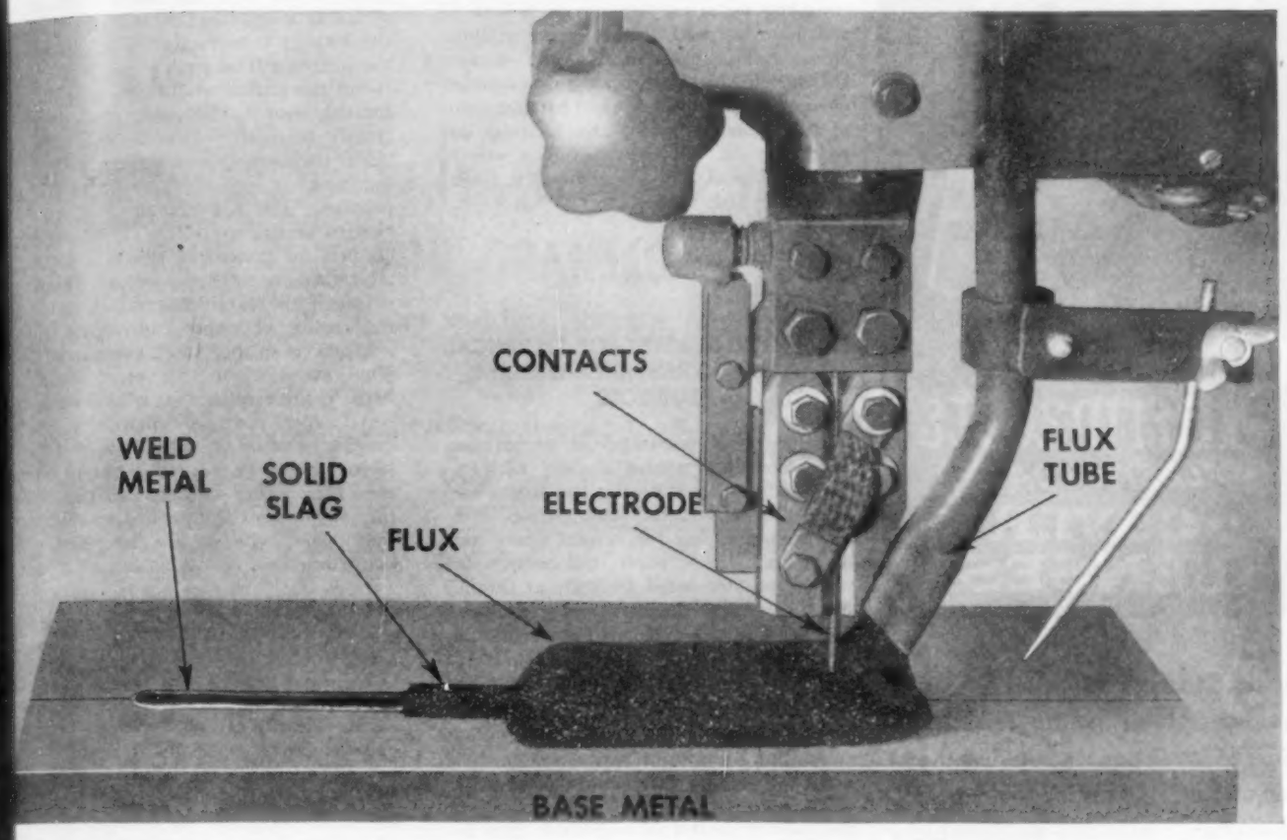
WELDED GEAR BLANK

The photograph shows a large half gear blank being welded. This is for a gear 145-in. O.D., 31-in. face. The piece shown weighs 17,354 lb. A feature of interest in this photograph is the rigging for preheating the piece. Note the pipe around the circumference with gas flames playing on the rim. There is also a nozzle pointed at the bore with gas and air lines connected to it.


Save with SIGHT FEED
ACETYLENE
Sight Feed
GENERATORS
● "Take care to be an economist in prosperity; there is no fear of your not being one in adversity:" Sound counsel for any businessman—including welders who spent over $85,000,000 for "bottled" acetylene last year, and this year can save fully two-thirds of that sum (over $56,000,000) by producing purer, hotter acetylene gas with Sight Feed Acetylene Generators. Be an economist in prosperity—save in '45 with Sight Feed!
THE SIGHT FEED GENERATOR COMPANY
Sales: Richmond, Indiana • Factory: W. Alexandria, Ohio
You SEE the Charge!

"IMPROVEMENT...the key," *he said*

Look, how Lincoln has improved the Shielded Arc Welding Process:



The Pioneer of Shielded Arc Welding Announces "LINCOLNWELD"

. . . key to better welding at lower cost

ielded completely under a blanket of flux, the arc of "Lincoln-eld" brings to the welding world new high standards of *speed, uality* and *economy*. Here are a few of the many advantages f this new Lincoln Automatic Metallic Shielded-Arc Process . reported by many users for a wide variety of applications:

ERSATILE. Same flux . . . same electrode . . . same procedure . . . n be used for wide range of steel analyses. With simple change f electrode size, same equipment welds thin sheets or heavy plates

ASY TO WELD HORIZONTAL FILLETS. Simple to change from butts to lets or laps. Deep-root penetration combined with high welding eeds assure welds of higher quality at lower cost.

PRODUCES HIGH QUALITY WELDS. "Lincolnweld" Flux gives quality results even in many steels of poor weldability.

ARC CONTROL IS SIMPLE. Balanced voltage type d.c. control . . . highly sensitive yet rugged and dependable.

TAKES WIDE RANGE OF ELECTRODE SIZES. Accommodates 1/8" to 7/32" electrode without change in head or control.

NOT SENSITIVE TO POWER LINE VOLTAGE VARIATIONS. Assures weld uniformity at all hours of day or night even though there may be voltage variations in shop power.

A booklet has been compiled giving "Lincolnweld" facts, procedures and results in a variety of applications. A free copy is yours for the asking.

THE LINCOLN ELECTRIC COMPANY • DEPT. P-1 • CLEVELAND 1, OHIO

America's greatest natural **recourse**

ARC WELDING

Ladd Stamps Says:

about Thermacote PLASTIC COATED ··COVER·· LENSES

Ladd Stamps says: "We save welder's time with THERMACOTE Cover Lenses because they last about 12 times longer without changing. Also our welders like them because they considerably reduce eye strain."

Ladd Stamps is Welding Supervisor for International Derrick and Equipment Company, Torrance, California. With 11 years of practical welding experience and a fine record of welding production, Mr. Stamp adds another name to the long list of experienced welders who prefer THERMACOTE COVER LENSES.

THERMACOTE CO.
122 Arlington Street, Newark 2, N. J.
612 No. Michigan Ave. 11, Chicago, Ill.
1101 McLaughlin Blvd. Portland 2, Ore.
420 South San Pedro Street
Los Angeles 13, California

ELECTRODE CATALOG

The Reid-Avery Co. has issued a de luxe catalog of its products. The booklet gives the classification and page index of Raco electrodes and welding rods, and complete technical data on each type of rod manufactured, including the applications, welding procedure, code acceptability, physical properties, recommended current ranges, sizes, color of coating, color of tip. The pamphlet also includes gas welding rods. Copy available on request of The Reid-Avery Co., Dundalk, Baltimore 22, Md.

$1000 PRIZE CONTEST FOR TECHNICAL PAPERS ON RESISTANCE WELDING SUBJECTS

In order to encourage the preparation of outstanding papers dealing with resistance welding subjects, the Resistance Welder Manufacturers' Association, Philadelphia, Pa., has for several years conducted a prize contest, the awards for which are announced annually at the fall meeting of the AMERICAN WELDING SOCIETY. The scope of this contest has recently been increased, bringing the total amount of the awards up to $1000. The prizes are to be awarded as follows:

One prize of $500 for the best paper emanating from an industrial source, consulting engineer, government laboratory, or the like, in which the major portion of the subject matter is concerned with design for resistance welding. This includes design of component parts to accomplish the maximum economy and welding quality and also details of procedure, work preparation and work handling, etc.

Two prizes of $200, each, will be awarded to the authors of two papers, not primarily concerned with design, which, in the judgment of the Board of Awards, are the greatest original contributions to the advancement and use of resistance welding. One of these two prizes shall go to the best paper emanating from a university source—that is, either an instructor, student, or research fellow at a recognized university. The second of these two prizes shall be awarded for the best paper emanating from an industrial source.

A fourth prize of $100 will be awarded to the author of the best remaining paper, which may fall in any of the three groups mentioned above.

The contest is open to anyone, without restriction, from the United States, its possessions and Canada. It is also open to any member of the AMERICAN WELDING SOCIETY in any grade from any place in the world. The contest is considered as having opened September 1, 1944, and will close on midnight, July 31, 1945. Papers which are to be presented at the Annual Meeting of the AMERICAN WELDING SOCIETY in October may also be entered in this contest, in which case a draft or copy of the paper must be filed with the AMERICAN WELDING SOCIETY not later than July 31, 1945.

All papers submitted in the contest become the joint property of the R.W.M.A., and the AMERICAN WELDING SOCIETY, who will retain all rights thereto. The AMERICAN WELDING SOCIETY will appoint five judges, who will judge the relative merits of the various papers submitted and make the awards accordingly. The decision of the judges will be final.

For the author or authors to be eligible for this award, the paper shall describe clearly original work done by them or under their supervision on resistance welding in any of its aspects by any method or process. The paper shall be a full disclosure of the subject. The paper shall contain no statement which is unethical advertising or sales promotion. The paper may contain statements of fact, including the names of either individuals or organizations of any kind, commercial designations, trade names, etc. The minimum length requirement is 2500 words.

All papers must be typewritten, double spacing, written on one side only of blank white paper. Photographs, charts, graphs etc., may either be attached directly to the copy or may be detached, in which case they should be clearly identified with figure numbers, captions, etc.

LAWSON JOINS INGALLS

Mr. Heathcote W. Lawson, who has been Welding Specialist for the Fabricated Structural Steel Division of Bethlehem Steel Co. for the past 14 years, has left that company to become Engineer of Research and Development for the Ingalls Iron Works Co., at their New York Office. Mr. Lawson is well known in the AMERICAN WELDING SOCIETY, a Past Chairman of the Philadelphia and Lehigh Valley Sections. He has been District Vice-President of the Mid-Eastern District for the past two years and is Chairman of the Section Advisory Committee. He has been active in committee work, particularly on the Subcommittee on Structural Research at Lehigh University.

Heathcote W. Lawson

PAGE *Welding* ELECTRODES

WHY WELDERS TAKE PAGE QUALITY FOR GRANTED

For the ticklish welding job—or any welding job for that matter—good results demand uniform electrodes.

PAGE believes that there is only one way to get real uniformity. And that is by rigid factory control of analyses, wire drawing and coating—constant factory test of welding results.

That's the **PAGE** way of making electrodes. And that's why those who know and use them take **PAGE** quality and uniformity for granted.

PAGE offers a wide range of electrodes and gas welding rods. Your **PAGE** distributor offers you the advantage of long experience in selecting the one best rod for each job.

Call your **PAGE** *distributor and ask for a copy of this new, informative, up-to-date booklet on welding stainless steel. Or, if you prefer, write to the factory for your copy.*

. . . Get in touch with Page

ACCO

Monessen, Pa., Atlanta, Chicago, Denver, Los Angeles, New York, Pittsburgh, Portland, San Francisco, Bridgeport, Conn.

PAGE STEEL AND WIRE DIVISION
AMERICAN CHAIN & CABLE

ACCO TRADE MARK

INCO MAN MADE TRENT TUBE MANAGER

Frank G. Flocke, of Westfield, N. J., for the past 15 yr. a member of Technical Service, Development and Research Division, The International Nickel Co., has been made General Manager of the Trent Tube Manufacturing Co., East Troy, Wis., producers of welded tubing in stainless steel, nickel, Monel, Inconel and other nickel alloys. He assumed his new position on February 1st.

F. G. Flocke

Graduated as a mechanical engineer by New York University, class of 1929, Mr. Flocke has specialized in the welding and fabrication of nickel and nickel alloys since joining Inco's technical staff immediately after graduation.

Mr. Flocke collaborated in such developments as the all-welded railroad tank cars made of nickel-clad steel and other clad steel projects, like the lining of the holds on fishing trawlers. He has traveled throughout this country and Canada in connection with problems involving the welding of nickel and nickel alloys in all forms from tubing to large structural shapes.

He is the author of many papers on welding of these materials delivered before or published by the AMERICAN WELDING SOCIETY and other professional societies. He has been secretary-treasurer of the New Jersey Section of the AMERICAN WELDING SOCIETY for the past two years.

SUSTAINING MEMBERS

United Welding and Construction Co., Inc., 2502–12 Edgemont St., Philadelphia 25, Pa.—Welded fabrications, welded steel construction and general maintenance welding, tool and die salvage and metal spraying. At present, its shop facilities are being used extensively in the fabrication of critical items for the Armed Services. United was formed primarily as a Service organization for Industrial units of all types in Metropolitan Philadelphia who do not have their own facilities for work covered by United's experience and capacity. Twenty-four-hour service is maintained at all times.

The Youngstown Welding & Engineering Company, Youngstown, Ohio, applies engineering to welding problems. In the field of weldments composed of nickel, copper, chromium, in various commercial alloys considerable fabrication is carried out in the company's plant. Composite metals are produced on a large scale. Stainless steel, nickel, Monel, Inconel, etc., are applied as a surface to baser metals.

SCIAKY BULLETIN

The New Sciaky bulletin, No. 113-A describes the series PMM-1 180-kva, seam welders. General information and tooling data are included in addition to actual machine specifications.

Copies will be sent to all those making inquiries to Sciaky Bros., 4915 W. 67th St., Chicago 38, Ill.

1945 APPARATUS CATALOG

The new VICTOR Gas Welding and Cutting Apparatus Catalog—104 pages—is the most comprehensive one issued in the industry.

Because of the cost of this particular catalog, its distribution will need to be restricted at least to the extent of "first come, first served."

Catalog includes complete technical

BRASS MAKES BULLETS

REGO Gas Plant Equipment to be safe, must be made of brass and other critical metals.

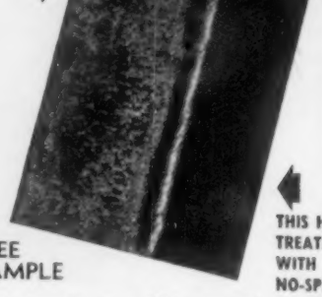
Conserve your equipment. You may not get more.

The BASTIAN-BLESSING Co.
4241 W. PETERSON AVE. CHICAGO
Pioneers and Manufacturers of Precision Equipment for Using and Controlling High Pressure Gases

for

BETTER WELDING at LOWER COST

THIS HALF UNTREATED



THIS HALF TREATED WITH NO-SPAT

FREE SAMPLE

NO-SPAT

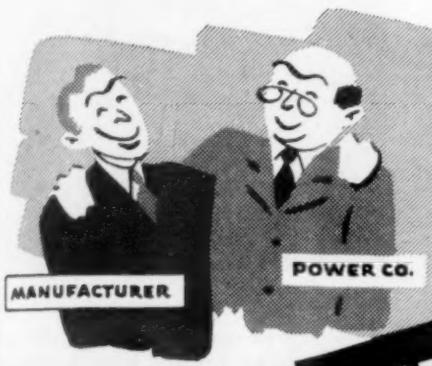
The Welding Fluid That Is Non-Toxic

NO-SPAT prevents welding spatter from adhering to metal surfaces — protects metal against rust — saves time and labor costs. Especially valuable in keeping welding jigs clean. Unbiased scientific tests show NO-SPAT maintains maximum welding strength — reduces fumes 30 percent — does not produce carbon monoxide. Extremely inexpensive. No mixing required. No time wasted. Apply and start welding at once. Write for FREE SAMPLE and detailed engineering test Bulletin.

THE MIDLAND PAINT & VARNISH CO.
Reno Avenue **Cleveland 5, Ohio**

NOW . . . RESISTANCE WELDING AT

Near Unity Power Factor (less KVA)



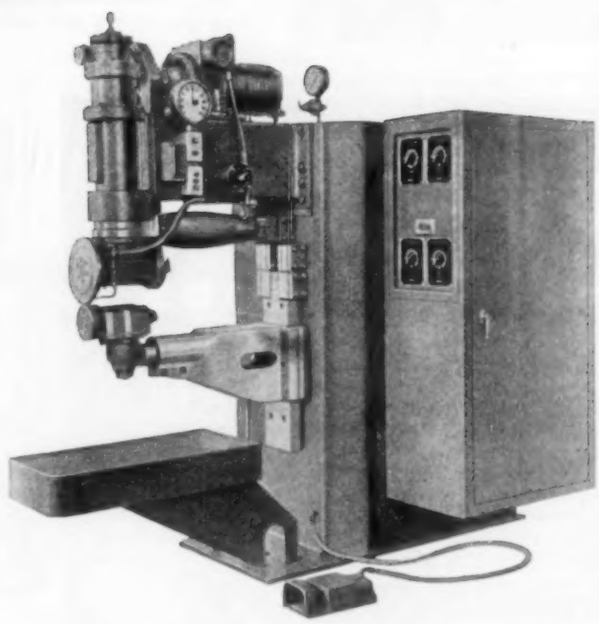
"THREE-PHASE"

Manufacturers and power companies have long been at odds over the problem of supplying power for heavy reactive loads. Particularly in the case of heavy duty resistance welding of steel, power suppliers have often found it necessary to place a ***demand charge*** on the manufacturer.

One reason for this is that conventional welders must utilize the comparatively high frequency alternating current in their secondary circuit. High frequencies mean high reactance, with resultant operation at very low power factor — often 25% or less. Low power factor means more current must be available to meet the same demand . . . often requiring a boost in the size of distribution facilities.

Sciaky "THREE-PHASE" welders are designed to overcome this, as well as other difficulties encountered in heavy duty resistance welding. An ideal low frequency current is produced at the electrode tips by an ingenious system of first, rectifying all three phases of the supply to d.c., then reconverting to an alternating impulse. Operation is on a ***balanced three phase load*** at ***near unity power factor.***

Bulletin 204-A describing fully the Sciaky "THREE-PHASE" principle will be gladly sent on request.



The Sciaky THREE-PHASE principle has been effectively applied to heavy gauge seam welding. The machine illustrated (type PMM.2T-13) welds steel up to two thicknesses of .109" and can achieve a speed of 84" per minute on two thicknesses of .040". Transformer rating is 120 KVA at 50% duty cycle. Unit is entirely self-contained with hinged side mounted rectifier and control cabinets. Electronic controls provide adjustable on-off time, squeeze and hold time.

SCIAKY BROS.

Complete line of AC and DC Electric Resistance Welding Machines
4915 West 67th Street, Chicago 38, Illinois
Offices in Detroit, Los Angeles, Washington, Cleveland and New York
Representatives in Principal Cities
In England: Sciaky Electric Welding Machines, Ltd., London
In France: Sciaky S.A., 13, 15 Rue Charles Fournier, Paris

data, design features and illustrations as to the use of Victor nozzles, torches, cutting attachments, cutting tips and torches including underwater cutting.

Copy available by request of Victor Equipment Co., 844-854 Folsom St., San Francisco, Calif.

CHICAGO BRIDGE & IRON COMPANY REOPENS LOS ANGELES OFFICE

The Chicago Bridge & Iron Company reopened its Los Angeles office on January 2, 1945. It is at the same location, Room 1105 in the William Fox Building.

The office is in charge of Dean E. Stephan who, for the past several years, has been assistant to James C. Vosburgh, Manager of the Chicago Bridge & Iron Company's office in Washington, D. C. Before going to Washington, Mr. Stephan was a member of the company's Birmingham sales office staff.

OXYACETYLENE PIPE-LINE DISTRIBUTING SYSTEMS

Victor Equipment Co. has issued an 84-page book giving a comprehensive review of the entire subject, from the production of calcium carbide and acetylene gas to the equipment needed for oxyacetylene distributing systems—replete with illustrations, charts and easily read engineering data. It answers, authoritatively, all pertinent questions.

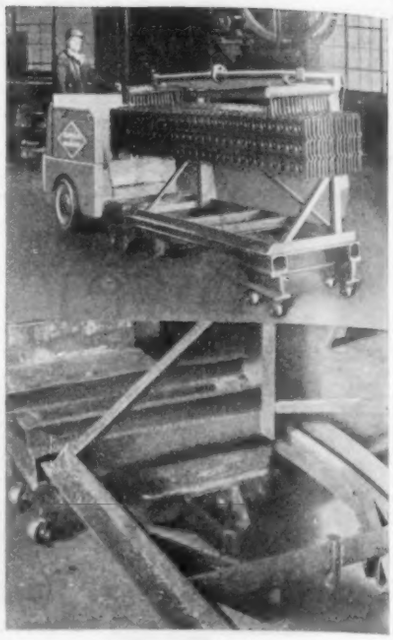
Free circulation of this book is restricted to engineers and welding department supervisors.

HANDLING LONG LOADS

In the manufacture of landing mat strips the handling and transportation of large unit loads by electric industrial trucks presented difficulties due to the ungainly dimensions of the material. Aisles were not wide enough to permit carrying the strips crosswise of the platform, and the standard platform was not long enough to permit carrying them lengthwise and have a well-balanced load. A wholly satisfactory solution was obtained by constructing an auxiliary dolly mounted on casters, which can be moved about manually to a limited degree and can also be transported rapidly between various operating departments by the electric truck.

The dolly was made by welding flame-cut parts of standard flat rolled shapes. A steel fitting bolted to the forward end of an Elwell-Parker power truck platform provides for a pin connection between the base frame and the truck. The truck lifts only one end of the dolly and can either push or pull the load through narrow aisles and around corners with ease and safety.

This arrangement for handling loads of long pieces has the advantage that the



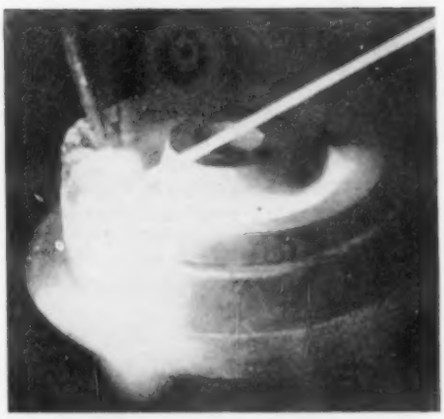
truck can be made quickly available for handling other types of loads on skids in the same plant. The superstructure illustrated was designed especially for handling landing mat strips. It can easily be modified to accommodate other types of material in long lengths such as tubes, bars, small trusses and the like. The Elwell-Parker Electric Co., Cleveland, Ohio.

Reach for
DUCTONE
(E6011) AC (E6013)
WELDING RODS
Available again, after three years of war service. DUCTONE AC rods are designed and manufactured especially for AC welding. It is the best rod for all position and general purpose welding. DUCTONE AC rods have deep penetration, are good on dirty materials and operate on exceptionally low current. Small sizes are especially good for thin sheet metal. Excellent for vertical and overhead welding on DC positive polarity. Extruded in all sizes from 1/16" to 1/4". See your dealer.
Territories Available for Distributors
DUCTONE AC ELECTRODES
Chicago Steel and Wire Co.
103rd St. and Torrence Ave.
Chicago 17, Illinois
Reach for DUCTONE AC Welding Rods

SPOT · BUTT · ARC
WELDERS
WRITE FOR CATALOG
We manufacture a complete line of resistance spot welders from ¼ to 300 KVA for all types of welding. There is an EISLER WELDER for every purpose.
TRANSFORMERS OF ALL TYPES
WE INVITE CONTRACT SPOT WELDING IN LARGE OR SMALL QUANTITIES.
CHAS. EISLER
EISLER ENGINEERING CO.
779-50. 13th ST. Near AVON AVE. NEWARK, 3 N. J.

It pays to use

AO Noviweld Didymium Lenses



because when your welder sees flare

instead of rod and molten area

you'll see added cost figures

. With a *clearer* picture of his work, the welder can lay *cleaner* beads. As a result, secondary operations—chipping, grinding and wire brushing—cost less in time and money.

Noviweld-Didymium Lenses enable the welder to look right through cloudy yellow sodium flare and see the rod and molten area clearly—with full protection against the dangerous hazards of ultra-violet and infra-red rays.

Right now, you can get immediate delivery of Noviweld-Didymium Lenses for the welding goggles of *all* of your operators in shade numbers 4, 5 and 6. Phone, wire or write to your nearest American Optical Branch Office today.

American Optical

COMPANY

SOUTHBRIDGE, MASSACHUSETTS

CHARLTON PROMOTED

Edward J. Charlton, who since 1942 has been Assistant to the President of Lukenweld, Inc., has been appointed Manager, Development Engineering, for Lukens Steel Co. and its subsidiaries, By-Products Steel Corp. and Lukenweld, Inc., it was announced recently by Robert W. Wolcott, President of Lukens.

Mr. Charlton was born in Philadelphia, Pa., where he attended high school and the Drexel Institute of Technology. Upon graduation from Drexel he entered the employ of Shepard Niles Crane and Hoist Co.

E. J. Charlton

In 1931 Mr. Charlton joined the engineering staff of Lukenweld as a Designing Engineer. He continued in this capacity until his appointment in 1940 as General Manager of Lukenweld, Inc.

Mr. Charlton is a member of The American Society of Mechanical Engineers, AMERICAN WELDING SOCIETY, American Society of Naval Engineers and the Engineers' Club of New York City.

ARC-WELDED ICE FIGHTER

Successfully challenging the heavy snow and icing conditions during the current cold wave, this newly designed machine whose construction was made possible by the arc-welding process, is clearing and widening vital traffic lanes near Cleveland, Ohio.

Ray Ferwerda, President of the F.W.F. Corp., Cleveland, Ohio, the designer and builder of this type equipment is no stranger to snow and ice. As an expert skater in his native Holland, he received his first experience in shovelling snow. The necessity for keeping the canals clear for skating from one town to another brought to him appreciation of the necessity of snow removal in winter.

The rugged hydraulically operated scoop quickly removed the 4 to 5 ft. of packed snow and ice shown here which had prevously defied standard types of bulldozers and plows.

Photo courtesy The Lincoln Electric Co., Cleveland, Ohio.

National

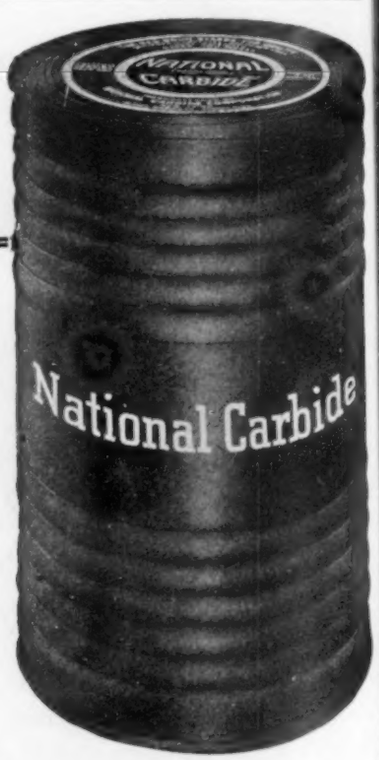
Carbide

IN THE RED DRUM

EFFICIENT

ECONOMICAL

DEPENDABLE

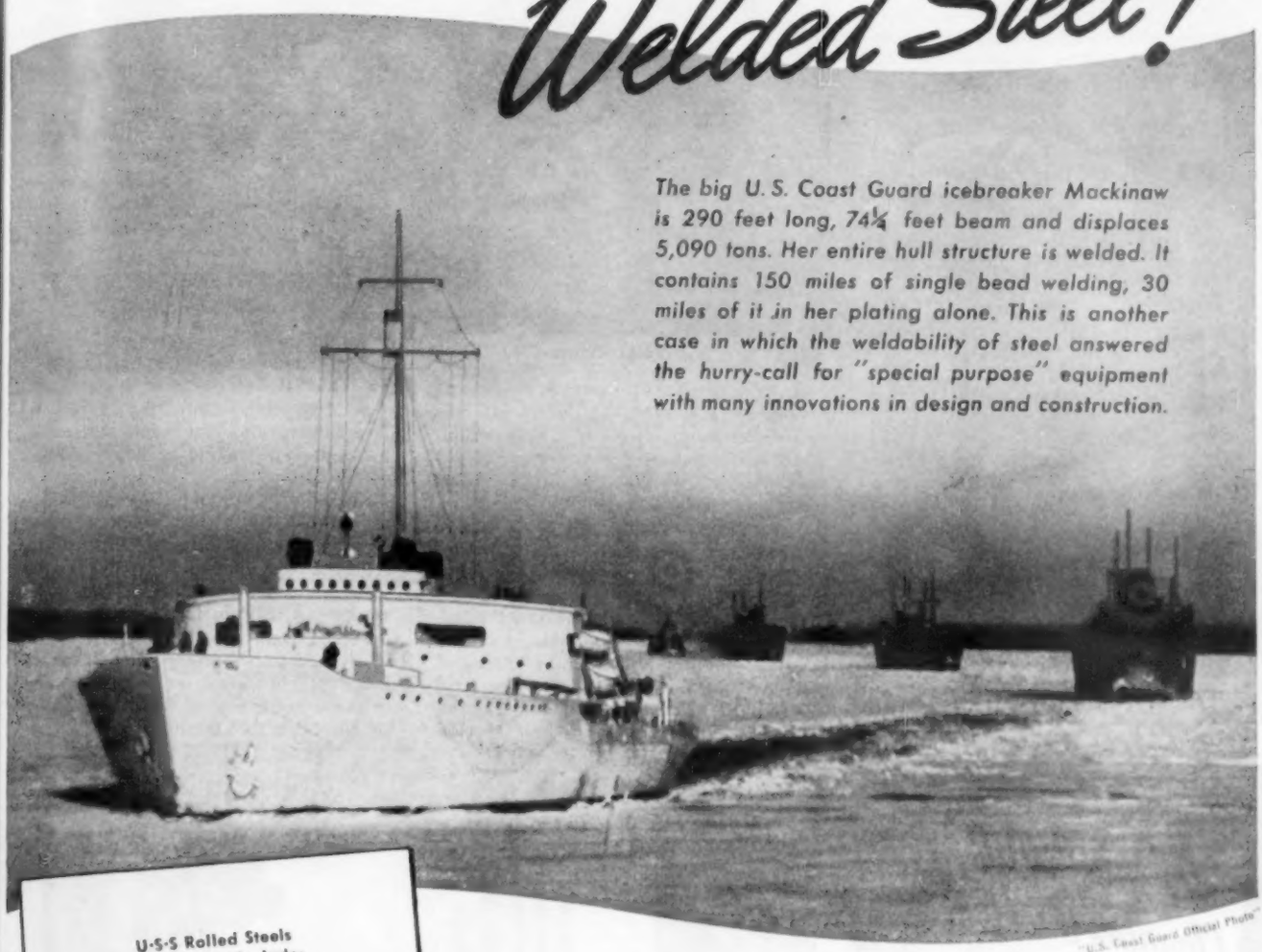


FOR WELDING and CUTTING

Use National Carbide in the Red Drum

60 E. 42nd St. NATIONAL CARBIDE CORPORATION New York, N. Y.

KEEPING VITAL CARGOES MOVING WITH *Welded Steel!*



The big U. S. Coast Guard icebreaker Mackinaw is 290 feet long, 74¼ feet beam and displaces 5,090 tons. Her entire hull structure is welded. It contains 150 miles of single bead welding, 30 miles of it in her plating alone. This is another case in which the weldability of steel answered the hurry-call for "special purpose" equipment with many innovations in design and construction.

"U.S. Coast Guard Official Photo"

U·S·S Rolled Steels for Welding Include:

U·S·S HIGH-STRENGTH STEELS *to resist atmospheric corrosion and increase strength without adding weight.*

U·S·S COPPER STEELS *to give twice the atmospheric corrosion resistance of regular steel at little additional cost.*

U·S·S HOT-ROLLED AND COLD-ROLLED STEELS *to provide the basic advantages of steel, plus maximum economy in accordance with the requirements of each job.*

U·S·S STAINLESS AND HEAT-RESISTING STEELS *to assure high resistance to corrosion and heat, and to reduce weight.*

U·S·S CARILLOY ALLOY STEELS—*Special steels for the special jobs of industry.*

EXACT knowledge of the weldability of steels you use is of prime importance in aiding you to turn out great quantities of war material—in record time.

Time, metal, and weight are saved—yet quality standards are maintained — by information that enables manufacturers to obtain the maximum benefits of welding.

Over the years, our research staff —through thousands of tests—has determined the physical properties of welds in all types of steel. This information has proved of great practical value to welding engineers and designers.

We shall be glad to supply you with authoritative information on welding properties that will enable you to select the type of U·S·S Steel best suited for each individual job.

Our technical staff will be glad to consult with you on your present problems and future plans which include welded steel. Drop us a line today, you incur no obligation.

U·S·S ROLLED STEELS FOR WELDING

CARNEGIE-ILLINOIS STEEL CORPORATION, *Pittsburgh and Chicago*
COLUMBIA STEEL COMPANY, *San Francisco*
TENNESSEE COAL, IRON & RAILROAD COMPANY, *Birmingham*
United States Steel Export Company, New York

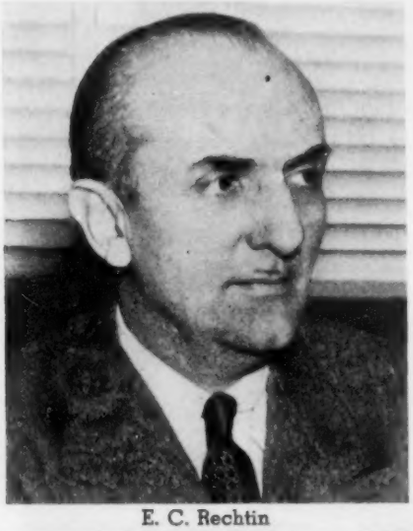
UNITED STATES STEEL

BETHLEHEM STEEL PROMOTIONS

A. B. Homer, Vice-President, Shipbuilding Div., Bethlehem Steel Co., announces the following changes in the executive staff of Bethlehem's San Pedro Shipyard, Terminal Island, Calif.:

E. C. Rechtin formerly Assistant Manager becomes General Manager, succeeding Thomas B. Forster, resigned. W. A. Harrington formerly Sales Manager for the Yard, is appointed Asst. General Manager.

Mr. Rechtin was graduated from Webb Institute of Naval Architecture. He became affiliated with Bethlehem when the Company purchased United Shipyards in New York in 1938. Subsequently he was appointed Assistant Manager at San Pedro in charge of New Construction. Mr. Rechtin has been a leader in the development of Welding for Marine Construction. He originated and developed the Serrated Channel System of Welded Construction which has been widely adopted. He was also active in developing the principles of welding large panel preassemblies and the application of automatic welding. His experience includes scientific and design work and planning of reconversion of vessels such as the USS *George Washington*. He is a member of the Society of Naval Architects and Marine Engineers, the AMERICAN WELDING SOCIETY and The Propeller Club.



E. C. Rechtin

W. A. Harrington

Mr. Harrington is well known in shipbuilding and ship repairing circles on the West Coast. He is an experienced shipbuilding and ship repairing man. He started work when 13 years of age and was successively a Printers Devil, a Rivet Heater in a Boiler Shop and a Journeyman Boilermaker before becoming allied with the Shipbuilding Industry. In the latter he has been a Loftsman, an Inspector of Ships for the U.S. Shipping Board and he also sat on the Claim Board for this later activity. He came to the San Pedro Yard as Chief Estimator in 1923 and later was General Yard Foreman and Sales Manager.

OIL FIELD ENGINE IMPROVED BY WELDING REDESIGN

An outstanding example of the benefits that are made possible through changeover to welded design is shown in the new all-welded gasoline engine for oil field service (see illustration) which has replaced the previous type engine of heavy cast-iron construction.

Over 25% less weight, lower initial cost easier portability and lowered maintenance are some of the principal advantages reported to The Lincoln Electric Co., Cleveland, Ohio, suppliers of the welding equipment used in fabricating the newly designed engine.

The redesigned power unit is a four-cylinder type operating on either natural gas or gasoline and is used for drilling oil wells by the cable tool method.

Is this YOUR Cleaning Problem?
Preparing Aluminized Steel Surfaces for Spot Welding
To prepare aluminum-clad steel sheets before spot welding, many plants are employing a NEW Oakite method specially designed for this work. This technique is proving remarkably effective and THOROUGH for quickly removing oil, grease, stamping compounds, identification paint and oxide films.
In addition, it makes possible a lower surface resistance. Flashing is minimized. Your operator is able to obtain more uniform, STRONG welds on a FAST production basis. Write for FREE Technical Bulletin giving full details!
OAKITE PRODUCTS, INC., 18E. Thames St., NEW YORK 6, N.Y.
Technical Service Representatives Conveniently Located in All Principal Cities of the United States and Canada
OAKITE
CLEANING
MATERIALS · METHODS · SERVICE

IN REGULAR PRODUCTION AT UNITED WELDING
ARMY E NAVY
Blower impellers, like those above . . . field rings like those below . . . are today regular "grist for our mill." That is war production. Soon, let us hope, things of a more peaceful nature will take their place.
You, no doubt, have or soon will have, products to market. Those products may be of a design that would gain through welded construction . . . for style . . . for strength . . . for lightness . . . to make them less costly to produce. If so, our engineers and our facilities can serve you to advantage.
Let us look at your drawings. Confidential of course. Get our quotations.
WELDING ENGINEERS
MIDDLETOWN OHIO
THE UNITED WELDING CO.
MIDDLETOWN, OHIO
WELDING FABRICATORS OF MODERN DESIGNS

The original employees of The Champion Rivet Co. prior to 1900. Mr. David J. Champion, founder, is at extreme left wearing derby hat.

A DEVIL AND AN ELEPHANT BEGAN A TUG OF WAR...

Today

BOTH ARE STILL GOING STRONG

The manufacture of VICTOR brand steel and iron rivets was begun by The Champion Rivet Co. in April, 1895. At that time the unique trade-mark featuring the elephant and the Devil vainly pulling on opposite ends of a Victor boiler rivet was created. The Strength which this strange pair typified has always been the chief characteristic of Champion rivets and half a century later they are still tugging with all their might.

In 1931 a line of CHAMPION WELDING ELECTRODES which won the immediate recognition of engineers and fabricators was introduced. Here again the Devil played a prominent role in the naming of the various rods and the design of the electrode trade-mark shown at left.

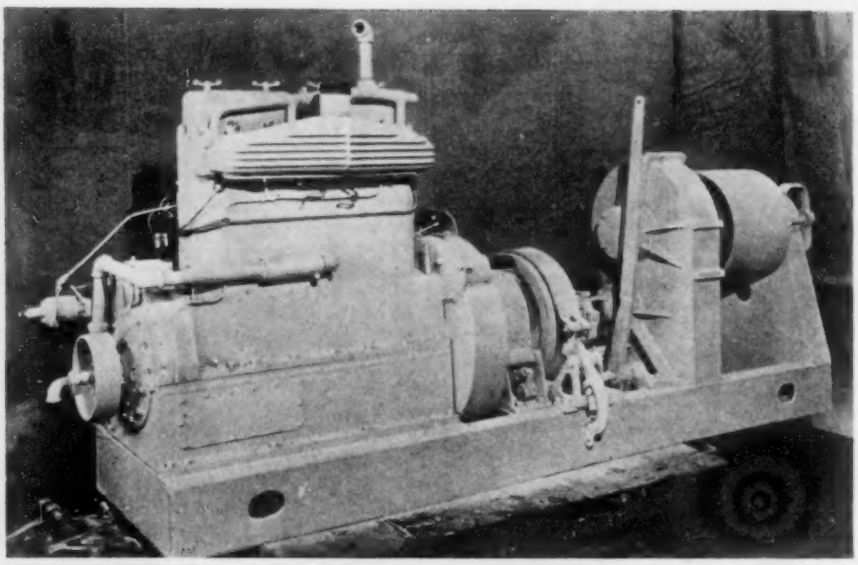
1895

The CHAMPION RIVET Co.

11400 HARVARD AVENUE • CLEVELAND, OHIO

EAST CHICAGO, IND.

1945



View of New 4-Cylinder Oil Field Engine of Welded Design Which Replaces Previous Engine of Cast Construction

The engine is operated at a speed of approximately 500 rpm. when drilling and 1500 rpm. when bailing a well or pulling tools. The unit has a rating of 120 brake horsepower at 1200 revolutions per minute. Cylinder bore is $4^{7}/_{8}$ in. with a stroke of 7 in.

According to the manufacturer, Buffalo Gasoline Motor Co., Buffalo, N. Y., welded construction offered them manufacturing advantages that eliminated costly foundry delays and expensive pattern making and maintenance. In further commenting on the reasons for turning to welded design, engineers of the company reported that "changes in design can be made more cheaply and quickly. More raw stock can be stored in less space than by casting methods. When we changed to welded steel construction we found our cost was lowered, and the surfaces required less smooth-on, filler and cleaning before painting.

"As considerable oil field drilling is done in rough and mountainous terrain," continued the report, "light weight is essential for rapid transportation and installation. This obviously reduces non-drilling time and increases the pay time." The engine is either mounted on wheels or on skids depending upon the particular type of field work and transportation needs.

The newly designed engine which has an all-welded steel crankcase, engine block, manifolds, base and gear reduction case, has withstood many months of severe field service where it has operated continuously, 24 hr. per day for periods of from 30 to 60 days.

The engine has proved so successful that the company is planning a long range production program involving new similarly designed all-welded oil field engines including 6-, 8-, and 12-cylinder sizes.

W. R. PERSONS BECOMES ASSISTANT SALES MANAGER

The appointment of W. R. Persons as assistant sales manager has been announced by J. F. Lincoln, President of The Lincoln Electric Co., Cleveland, Ohio. In his promotion to this new post, Mr. Persons will act as assistant to C. M. Taylor, vice-president and general sales manager.

Among his activities concerned with the advancement and supervision of the entire Lincoln sales program, Persons will assume the responsibility of developing certain specific fields for Lincoln products. In this connection he has been working on special assignments since his transfer to the Lincoln home office at Cleveland several months ago. He is also chairman of the firm's Junior Board of Directors.

Mr. Persons has been with the company for the past 10 yr. Born in Painesville, Ohio, in 1909, he obtained his college education at Case School of Applied Science where he received an M.S. degree in engineering.

When he finished school, having decided to enter the fast growing industry of welding, he applied to The Lincoln Electric Co. for a job. Being told there was nothing open, he determined to make a place for himself and took the company's welding course and insisted on helping the instructor on his own time in order to get experience. Being impressed by his sincerity and determination, "Buck" as he is commonly known in the industry, was assigned to the position of sales and service representative in western Pennsylvania. Four years later, he was appointed branch manager of the firm's Pittsburgh office, continuing at this post until his transfer to Cleveland last year.

W. R. Persons, Assistant Sales Manager, The Lincoln Electric Co., Cleveland, Ohio

While at Pittsburgh, Persons was particularly active in local organizations and civic affairs. He was responsible for the development of numerous welding engineering programs in western Pennsyl-

Buy "Proven Fluxes" with Years of Guaranteed Satisfaction behind them

The Trade-Name is "ANTI-BORAX"

Ask for Them ***Unequalled for Quality***

A Flux for every metal: Cast Iron Welding Flux No. 1; Brazing Flux No. 2; Braz-Cast Flux No. 4, for bronze-welding cast iron; "ABC" Aluminum Flux No. 8 for sheet Aluminum and all alloys of Aluminum; Stainless Steel Flux No. 9; Silver Solder Brazing Flux No. 10; No. 16 Silver Solder Paste Flux.

ANTI-BORAX COMPOUND COMPANY
Fort Wayne, Indiana

AN IMPORTANT *Tobin Bronze Repair Weld* STILL GOING STRONG

MORE THAN A YEAR AGO there was a breakdown at the Torrington Mills of The American Brass Company. A specially-designed draw bench set up for critical war production was shut down by the fracture of a 5200 pound cast iron cylinder. Regardless of directives and priorities, weeks of time would be required in pattern making, casting and machining before a new cylinder could be installed.

To save time, a bronze repair weld, requiring 196 pounds of Tobin Bronze*, was made by the J. L. White Welding Company, of Waterbury, Connecticut, and production was speedily restored to normal.

Today, more than a year later, this same cylinder with the "temporary" repair weld, is still in operation, having met progressively heavier production demands through the months.

This is one more example of what we mean when we say to American industry "Don't scrap it, *weld* it!" With Anaconda Welding Rods, such as Tobin Bronze and "997" Low Fuming, production schedules have been saved, priceless machinery salvaged, time and time again during this national emergency. 4659

*Reg. U. S. Pat. Off.

THE AMERICAN BRASS COMPANY
Subsidiary of Anaconda Copper Mining Company
General Offices: Waterbury 88, Connecticut
In Canada: ANACONDA AMERICAN BRASS LTD., *New Toronto, Ont.*

ANACONDA

Anaconda Welding Rods

vania and West Virginia, was a director of the Pittsburgh Junior Chamber of Commerce, and chairman of the city's Man-Marketing Clinic. He also held memberships in the executive council of the Boy Scouts of America and the Chartiers Country Club. He is a member of the AMERICAN WELDING SOCIETY.

SWAPS FRYING PAN FOR TORCH

Vera Anderson McDonald, world's woman welding champion, is carrying the torch for victory again at the Ingalls Shipbuilding Corp. yard in Pascagoula, Miss.

The winsome miss became a bride and housekeeper several months ago when she married Sergeant Anselm McDonald, of the Army Transportation Corps, but recent military reverses sent her scurrying back to the yard to help weld giant attack transports. The 21-yr.-old welder won her title in two contests with opponents from Pacific Coast yards. She has served as welding instructor and examiner since joining the yard soon after the war began. Now she is working as a regular welder.

TECHNICOLOR FILM ON ARC WELDING

A new Technicolor sound motion picture titled "Magic Wand of Industry—Arc Welding," just released by The Lincoln Electric Co., Cleveland, Ohio, portrays the dramatic progress of arc welding from its beginnings to its present vital wartime role. There are also scenes which take the audience into the welding world of tomorrow.

Produced at the request of the U. S. Bureau of Mines which is releasing the picture under the title "A Story of Arc Welding," this 25-min. presentation, filmed under the technical direction of Lincoln welding engineers, was staged and photographed in practically every major industry including airplane factories, shipyards, refineries, steel mills and Shasta Dam.

Primarily educational, the film graphically presents the fundamentals of arc welding, the electrical circuit and the types of welded joints. The true action inside the arc is also revealed for the first time in actual photography and animation, showing the penetrating "arc force" which assures high strength and good fusion of all metals. To obtain the photographs of the arc, it was necessary to use a battery of arc lights using power equivalent to 4500 automobile headlights all focused on an area of one square foot.

In addition to being educational and informative, the film was produced also to attract men and women into the many arc welding jobs that now need to be filled.

The film is available in 16-mm. and 35-mm. prints to business groups, technical societies, schools and colleges and industrial plants at no charge except transportation. A short version of "Magic Wand of Industry—Arc Welding" is scheduled for theatrical showings throughout the country.

The Technicolor release may be obtained on request from The Lincoln Electric Co., 12818 Coit Rd., Cleveland 1, Ohio, or from the U. S. Bureau of Mines, Experimental Station, 4800 Forves St., Pittsburgh, Pa.

HOLSLAG'S SATIRICAL HISTORY OF ARC WELDING

C. J. Holslag gives herewith a brief, satirical history of arc welding as follows based on the lyrics and music of the song "Accent-u-ate the Positive, Eliminate the Negative, Don't Mess with Mr. In-between." We quote:

"In the very earliest days of welding when the trolley car companies took up welding they had distinctive positive electrodes because the negative was in the street.

"Shortly thereafter the railroads took up welding for repair and maintenance but were not to use anything but negative electrode. The writer had to travel hundreds of miles to reverse generators which had become positive, if there hadn't been meters on them they wouldn't have known the difference.

"During the 10 or 20 yr. or nearly two decades of straight polarity which is really negative on the electrode, the trolley people kept on using the positive or reversed polarity because they didn't have any other way to accomplish their purposes.

"In the last decade or 15 yr. positive electrode has come into being and to use negative electrode is now heresay and during all these days or most all up to lately. It was distinctly taboo to use alternating current which is Mr. In-between.

"The modern electrodes allow positive, negative d. c. or a. c., and the popular song quoted is very appropriate with that other popular song 'Don't Fence Me In' with specific polarity as the conditions which require it are now a rarity."

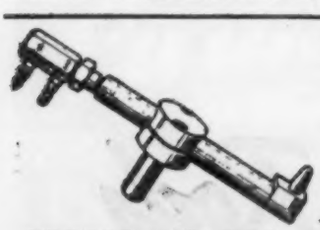
P & H ADDS TO WELDING STAFF IN CHICAGO

As of February 1st, Harnischfeger Corporation has appointed Chester O. Barnes as Welding Engineer in the Chicago and Milwaukee territories under the jurisdiction of the Home Office at Milwaukee. His transfer to field work was preceded by a long term of service in practical welding in P & H's own shops, giving Mr. Barnes a valuable background for his new responsibilities. Also effective February 1st, C. H. Wyman, Welding Engineer, has been added to P & H's Chicago Branch.

B & W TUBE COMPANY EXPANDS STAINLESS FACILITIES

Beaver Falls, Pa. March 18th.—The Babcock & Wilcox Tube Company here, the first to make stainless steel tubing in the United States, and long associated with seamless tubing, is now expanding facilities to include the manufacture of atomic hydrogen welded tubing and pipe, it was announced today.

The rotary piercing method is eminently suited for the larger diameters and heavy walled tubing such as cracking still tubes and the like, while the atomic hydrogen welded process is better suited for smaller sizes of tubing such as are used in the food and chemical industries it was stated at the plant. Regardless of the initial method of manufacture, the Tube Company facilities for subsequent processing such as annealing, pickling, cold drawing, straightening, etc., are identical.

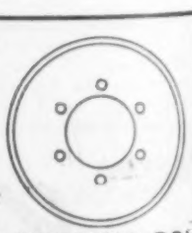


"ELECTROLOY" for RESISTANCE WELDING

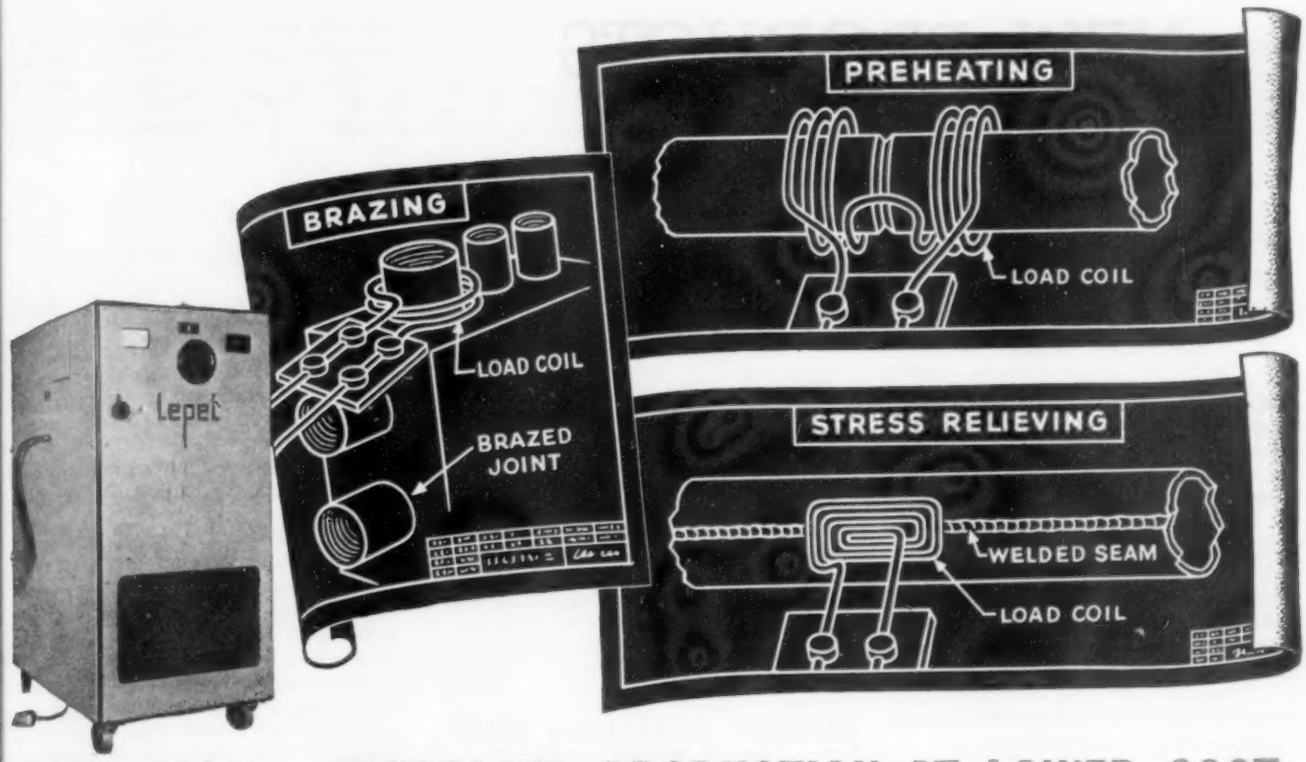
Butt
Flash
Spot
Seam
Projection

ELECTROLOY

Catalog and prices on request



THE ELECTROLOY CO. INC. 1600 SEAVIEW AVE. BRIDGEPORT, CONN.



One compact, portable Lepel Unit performs all hardening, stress-relieving, soldering, brazing and melting operations. Readily convertible to peace-time production at no expense.

INCREASED PRODUCTION AT LOWER COST

with High Frequency Induction Heating for Pre-Heating, Stress-Relieving, Metal Joining

Lepel Induction Heating produces heat up to any selected temperature exactly where it is required for the proper period of time necessary to produce the desired results. It is astonishingly speedy in operation, reducing heating time from minutes to seconds, yet it works with a degree of accuracy and efficiency rarely obtainable by other methods.

Pre-Heating, Stress-Relieving

Lepel Induction Heating is used by many leading industrial plants for pre-heating before welding or stress-relieving welded seams. In such applications, it affords remarkable economies in time and cost with further advantages of uniformity and heat-concentration which prevents structural changes in sections of the metal outside the field of the load coil. In many instances, heating can be performed as a continuous operation, further reducing time cycles and costs.

Metal Joining

Lepel Induction Heating also quickly and neatly performs the most intricate brazing and soldering operations on all ferrous and non-ferrous metals, using brazing alloys from lowest to highest melting points. By pre-fluxing and pre-placing of the alloy in the form of rings, strips, or irregular shapes, many complicated production brazing jobs are reduced to quick, simple operations which can be performed by any unskilled worker. May be operated manually or fully automatic.

Consider the possibilities of Lepel Induction Heating applied to your present and post-war production. Lepel engineers will gladly aid you in working out the details of the application.

Lepel

LEPEL HIGH FREQUENCY LABORATORIES, INC.

PIONEERS IN INDUCTION HEATING

39 WEST 60th STREET **NEW YORK 23, N. Y.**

HIGH FREQUENCY INDUCTION HEATING UNITS

NEW PRODUCTS

The Society assumes no responsibility for the validity of claims in this Section

ELECTRODE CHART

The new Murex Wall Chart, serves as a useful guide in selecting the proper electrodes for individual welding jobs. The chart contains a list of Murex electrodes divided into four groups for quick reference, including (1) mild steel, (2) special steels, (3) stainless steels and (4) hard surfacing.

The electrodes are described according to A.W.S.-A.S.T.M. class, with color identification, recommended current strengths, polarity and physical properties. There are also brief descriptions of the general characteristics of the Murex electrodes and their applications.

Copies will be sent without charge to readers at request upon company letterhead. Metal & Thermit Corporation, 120 Broadway, New York, N. Y.

SPOT WELD SEALER

The Presstite Engineering Co., St. Louis Mo., has announced the successful development of three types of Presstico Spot Weld Sealer, produced as flow gun, brush or spray type. These sealing compounds are made to give a seal between plates that are spot welded together.

Tests have been made using a $3^1/_2$- x 10- x 10-in. box made by spot welding all seams at 3-in. pitch, using Presstico Sealer in the joints and the box being then filled with water. Sample lap joints were made up, X-rayed and then sheared into tensile specimens. Other panels using the same joint were run through the paint system with or without bonderizing and left in a salt spray for two weeks.

All specimens tested for a tensile strength to 2600 lb. X-ray showed all good welds and the box did not leak throughout the two weeks of test. The sealing compound gave no difficulty in the paint process and stood up satisfactorily in the salt spray test also. Spot-welded panels, put through the complete bonderizing cycle, including a three-minute dip at 210° F. in 2.5% Caustic Potash, revealed no deleterious effects on the material in the seam. The material itself has no corrosive effect on metals. Spot-welded panels sealed with Presstico Spot Weld Sealer show good protection at the seam when kept in 100% relative humidity at 100° F. for one week.

Full information may be obtained from the manufacturer, Presstite Engineering Co., 39 Chouteau Ave., St. Louis 10, Mo.

ELECTRODE DISTRIBUTOR

Whitehead Metal Products Co. has been appointed eastern distributors for SMITHway certified welding electrodes, Thomas H. Bohen, president, announces.

SMITHway electrodes are manufactured by the A. O. Smith Corp., of Milwaukee, Wis. Complete stocks will be carried in the Whitehead Co.'s seven warehouses in New York City, Philadelphia, Boston, Newark, Buffalo, Baltimore and Syracuse.

PULVERIZED SILVER ALLOY BRAZES SMALL ROUND WIRES

A new method of brazing small round wires with diameters of 0.0226 to 0.049 in., has been adopted in the Distribution Transformer Division at General Electric's Pittsfield Works. A mixture consisting of equal amounts of filed silver solder and borax flux is used.

The end of one of the two wires to be brazed is either moistened or heated and then inserted in the container holding the mixture. When a sufficient amount adheres to the wire, the two ends being brazed are placed together and heated over a gas flame until the alloy fuses them. If normal heating is applied the joint will be free of lumps and points, eliminating a finishing operation before the braze can be insulated.

In the conventional method of brazing these small wires a strip silver alloy and flux was used. This resulted in a loss of the silver both from drip at the braze and from an excess of brazing material at the point of contact. The new method has resulted in a saving of approximately 80% of the strip silver alloy.

200-AMP. PRODUCTION [WELDER]

Completing the G-R line of "C" models (power-factor corrected production welders), the G-R models 25C and 35C represent the first transformer-type welders of the heavy-duty production type to be offered in the 200- and 250-amp. rating.

Welding range of the 25C is 15 to 230 amp.; it is designed for continuous use on a 60% duty cycle, and is Underwriter's approved.

G-R's line of "C" models now range from the 10- to 100-amp. model 10 to the 15- to 330-amp. model 35C. These units feature built-in power factor correction spun glass transformer coil insulation, heavy-duty design with larger cores and increased copper for 'round-the-clock production welding, and extremely wide output range—all models will cut down to handle a $^1/_{16}$-in. electrode. Weight of the new units indicate the exceptionally large size of the heavy-duty transformer; the model 25C weighs 320 lb. and the model 35C, 380 lb.—nearly double the weight of intermittent-duty welders of the 200 to 250-amp. class. With G-R's exclusive flux-diversion type of "stepless" heat control, input is directly proportional to output. Power factor increases at lower input, contributing a leading power factor to the plant system when welding at lower heat ranges, or during nonwelding periods with primaries connected to the line.

In addition to the "C" models, the G-R line of heavy-duty production welders includes machines with ratings to 2500 amp., in manual and automatic types.

Descriptive literature may be obtained from Glenn-Roberts Co., 3100 E. 10th St., Oakland 1, Calif., or 2107 Adams St., Indianapolis 1, Ind.

PROCESSING ELECTRODES

Several features new to the welding rod processing industry were introduced in the newest complete processing plant designed and built by the Moslo Machinery, Cleveland, Ohio. First in the interest of a group of welding engineers and technicians who viewed the plant was a new principle of extruded flux application employing a die head set at a 60° angle. Additional new features are, a centralized control panel by which one man can start and stop every unit in the plant, a compacted seven-pass oven saving 40% on floor space and an improved mechanism which transfers the electrodes from one pass within the oven to the next in accurate alignment without dropping or rolling. A new type of slug press by the same designer is a part of the equipment shown. Installed with the hydraulic piston partly below floor level, this press can be charged and the slugs removed at the operator's waist height.

Jonesy Learns about Genex C

JONESY, our welding super, was sitting as pretty as any guy with a mug like his can sit. No beefs from the customers; no screams from the Lords of Creation in the front office. Our jobs were mostly downhand, "hot-rod" stuff, calling for Murex F or FHP electrodes. In fact, call for anything other than Murex on those jobs, and Jonesy would roar like a bull.

Then in comes this new job, #2XW31. I'm Jonesy's assistant; we gave the drawings and specs a careful once-over. To me it looked like a job for Genex C.

"Right much carbon in that steel," I mentioned. "Calls for a colder arc than the run of our jobs here, so we won't pick up lots of carbon and get a brittle weld. I'd say we want a 6012 electrode. Okay?"

"Okay," Jonesy agreed, and I picked up the phone and put in a call for Murex.

"Hey," Jonesy yelled, "Nix." He grabbed the phone out of my hand. "Look," he roared, "Murex may make the best downhand hot rods money can buy, but I don't know about their others. Call some other outfit."

I argued as long as you can with a boss like Jonesy. I tried to tell him that Murex has two of the best 6012 rods made (Genex and Genex C)—plus about 30 other electrodes, each one as good in its place as their famous hot rods. No soap, though; Jonesy knew better.

So I called up some other outfit—several in fact—and we tried their 6012 rods. Unit after unit of Job #2XW31 came off the jigs cracked in the weld. Too much heat and pickup of carbon. Jonesy raved for a week, then finally broke down.

"Say," he asked me, sort of sheepish, "how about calling Murex?"

I called Murex and they sent us a batch of their Genex C. Job #2XW31 was off the floor in two days—and no job's licked us since, thanks to Murex.

METAL & THERMIT CORPORATION

120 BROADWAY, NEW YORK 5, N.Y.

ALBANY • CHICAGO
PITTSBURGH • SO. SAN FRANCISCO
TORONTO

P. S. I've since found a simpler way to put lads like Jonesy wise as to the score on Murex. You just send for the new, big Murex wall chart and tack it up over his desk. The chart divides Murex electrodes as to use on mild, low-alloy, stainless and hard-surfaced steels; also shows at a glance the AWS-ASTM grade, polarity, current, etc., of each electrode. No arc-welding department should be without one. Just drop a line to Metal & Thermit Corp., 120 Broadway, New York 5, N. Y. No charge or obligation.

MUREX
Electrodes

Fast production of slugs, with a minimum of operator fatigue are among the advantages indicated.

The new plant, first of its kind, was built as a part of expansion program of the American Manganese Steel Division of the American Brake Shoe Company's Chicago plant. It is for production of their special manganese alloy rods with a capacity of 350 coated rods per minute, was inspected in operation by E. L. Quinn, manager of the Welding Division of American Manganese.

Smoother operation of the plant and greater uniformity of coated rods is achieved by the newly designed die head in which the flux is extruded onto the wire at an angle of 60° in the normal direction of rod flow, rather than at right angles as in conventional die heads. Another new feature in this plant is delivery of extruded rods directly onto the brushing machine without use of a transfer conveyor. The unit control panel is unique in plants of this type. On it are start-stop controls controlling each unit in the complete plant plus a single emergency button controlling all units. One man, at the main operating station, thus has full command of controls without moving from the central operating station. In addition, a newly patented electronic safety control which is a part of the transfer mechanism, shuts down the entire plant in the event of misalignment of rods at any of the transfer points, which might cause the system to jam.

The transfer mechanism itself was a center of keen interest during inspection of the Moslo plant. An ingenious revolving carrier literally picks up the rods from one pass and places them in the same alignment on the new pass. In the new compact oven there is no dropping or rolling in the transfers.

A number of radical changes in heat treatment are incorporated in the Moslo oven. The continuous chain conveyor is arranged so that seven passes are housed in an insulated chamber less than 4 ft. high and 25 ft. long. Closely controlled humidity is applied to the first two passes and a damper-balanced duct system assures constant circulation. Excess heat and humidity are evacuated to a duct for connection to the outside of the building. An insulated partition separates the first two passes from the rest of the travel. Temperature and humidity are graduated to control the speed of drying, assuring the specified degree of flux hardness in the finished rods.

The oven is built in sections which, like the individual production machines in the plant, can be shipped as assembled units, minimizing the problems or erection when delivered.

The process of making electrodes consists of the preparation of wire, preparation of flux, combining the wire and the flux and subsequent drying of flux.

Wire fed through a straightening and cutting machine is cut into lengths about 14 in. long. A mixing machine thoroughly mixes the flux which is placed into a hydraulic press forming cylinders or "slugs" with the wire placed in the feeding machine and the "slugs" of flux inserted in the cylinder of the extrusion press, the plant is ready for production. One man controlling the operation of the entire plant from a centralized station of push buttons starts the plant in motion.

The flux under 10,000 psi. is forced through the die head and units with the wire as it passes through from the feeder.

The coated welding rods are conveyed through brushes which clean the ends for contact necessary in the actual operation. After brushing, the electrodes move into the new 7-pass oven conveyor system in which the electrodes are carried through different controlled degrees of heat, air and moisture and placed (not dropped) on successive conveyors as they pass through the oven.

Better and more thoroughly processed electrodes are produced in the new plant.

From the oven, the electrodes are conveyed to an inspection table where they are inspected and packaged for delivery. Mr. Moslo stated that the company is prepared to offer the same type of design in complete plants with capacities up to 1000 electrodes per minute.

BRAZING PLATE CONNECTOR TO CAP OF 833A TUBE

Brazing technique is applied in fastening plate connector to the cap on 833A transmitting tubes at the Dobbs Ferry, N. Y., plant of North American Philips Co., Inc. The plastic protective screen

protects the operator in the event that the tube shatters. The company also produces large quantities of cathode ray tubes, quartz crystals, electronic measuring instruments, fine wire and X-ray (medical and industrial) equipment.

ELECTRODE FOR HEAVY WELDMENTS

A new heavily covered arc-welding electrode for flat and horizontal fillet welding as well as for flat butt welding has been announced by the Electric Welding Division of the General Electric Co. Desirable wherever weld requirements include high mechanical properties, rigid X-ray examination, good profile, high deposition rate and good surface appearance, the applications of this electrode include pressure vessels and pertinent connections, heavy machine bases and structural parts

such as column plates, columns, roof trusses, beams and girders where the thickness of the section permits.

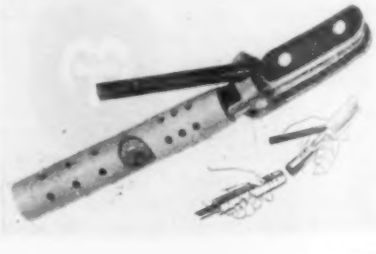
Known as Type W-27, the new electrode is characterized by an exceptionally high melting rate which results in increased production and higher speeds at the same welding current as other electrodes. At comparable production speeds, Type W-27 requires less heat input to the joint, thus reducing warpage and internal cooling stresses. These features, plus its ability to operate through a wide range of current, and freedom from undercut, suggest the use of Type W-27 for a great many war production tasks.

Readily recognized by its steady, forceful, spray-type arc, the new electrode operates on alternating current or direct current with either straight or reverse polarity. It has low spatter loss and easy slag removal and produces welds of excellent appearance. It is available in three sizes: $^{3}/_{16}$ x 18 in., $^{1}/_{4}$ x 18 and $^{5}/_{16}$ x 18 in., and is rated A.W.S. classes E6020 and E6030.

ELECTRODE HOLDER

An electrode holder designed so that the front assembly may be readily detached by hand, without shutting down the welding machine, has been developed by Detroit Electrode Holder Manufacturing Co., 2056 Forest Ave., West, Detroit 8, Mich. The holder—identified as the Marine Model—is of the resilient-jaw type, fully insulated. It is said that removing or reattaching the front requires but 15 sec.

The manufacturer recommends that operators be instructed to remove fronts whenever they leave the job, even temporarily, stating that holder may then be left anywhere without danger of an arc.



Unretouched photograph of the original Machlett Laboratory

The Machlett "White Room", first in the industry

Machlett Laboratories, Springdale

EVEN 43 YEARS AGO Machlett TUBES WERE PRAISED

Machlett Laboratories, Norwalk

Machlett Diffraction Tube with beryllium window. Used in analyzing quartz crystals for war and other radio purposes, and in metallography.

IN 1902 Dr. W. J. Morton, distinguished scientist, doctor and pioneer in the then-new field of roentgenology, wrote to Robert H. Machlett:

"My special tube, as you manufactured it, is truly a success and I don't know how I could obtain anything better. Please make me another one as soon as you possibly can."

Though little was known about X-rays at that time, one thing was clear to the men using them: the best tubes available were made by Machlett. We believe that is still true today.

The transition from the original Machlett Laboratory to the two modern plants at Springdale and Norwalk, Connecticut, was a gradual process. It was made possible by constant improvement in the tubes, by developing new techniques for their manufacture, and by designing and making new types for new applications. Thus Machlett became the largest producer of X-ray tubes in the world.

Today we also apply our half a century of experience to the production of other electron tubes, such as oscillators, amplifiers and rectifiers for radio and industrial uses. For information as to available types of Machlett tubes, write Machlett Laboratories, Inc., Springdale, Connecticut.

MACHLETT

RAY TUBES SINCE 1897

TODAY THEIR LARGEST MAKER

A further recommendation is that all fronts be turned in at the close of each shift for inspection and such repairs as may be necessary T. S. Donnelly, general manager, states that this procedure affords the safety values of a fully insulated holder at all times.

Aside from safety, Mr. Donnelly calls attention to the higher efficiency resulting from providing welders with newly conditioned tools at each shift; and the reduction in time consumed by the Electrical Department in making cable connections.

Detailed description of the detachable front holder and the recommended system of use will be sent by the manufacturer on request.

AUTOMATIC WELDING OF WATER TUBE BOILER DRUMS

An interesting application of the latest automatic arc-welding process consists of the fabrication of water tube boiler drums by the Struthers Wells Co., Titusville, Pa.

A considerable saving in time and costs was reported by this company over the previous method of manual welding.

The job consists of 70,000 psi. high-tensile steel plate drum, measuring $1^{9}/_{16}$ in. in thickness, all automatically welded with a new type of automatic welding known as the "Lincolnweld" (Trade Mark Registered) developed by The Lincoln Electric Co., Cleveland, Ohio.

The equipment at Struthers Wells Co. consists of a travel beam on which is mounted the automatic welding head flux receptacle and control box as seen in Fig. 1.

The welds are made with one weld on the inside seam and two passes on the outside seam.

The positioning fixtures are made up of a support for the longitudinal weld only. Heads of the drum are welded by manual welding, being beveled for this type of fabrication.

Positioners are employed for some shell fabrication, using chuck head positioners, then turning the chuck head by moving the rotating plate of the positioners.

Size of the drums is 50 in. in diameter by 8 ft. 6 in. in length. The vessels are built to withstand a pressure of 900 psi.

A suction flux salvage unit is used to reclaim the flux for further use.

Details of, "Lincolnweld" Automatic Arc Welding

This development, to meet the need for a more foolproof and easily applied process, has established its practicability over a period of several years during which a number of the units have been highly successful in welding a variety of products, among which are machinery bases and beds, motor and generator frames, ventilating fans, tanks and pressure vessels of all kinds, LST landing craft, and many parts used in the prefabrication of ships, railroad cars, etc

It has been successfully used in welding all types of joints including butt, lap, tee and fillet, as well as corner.

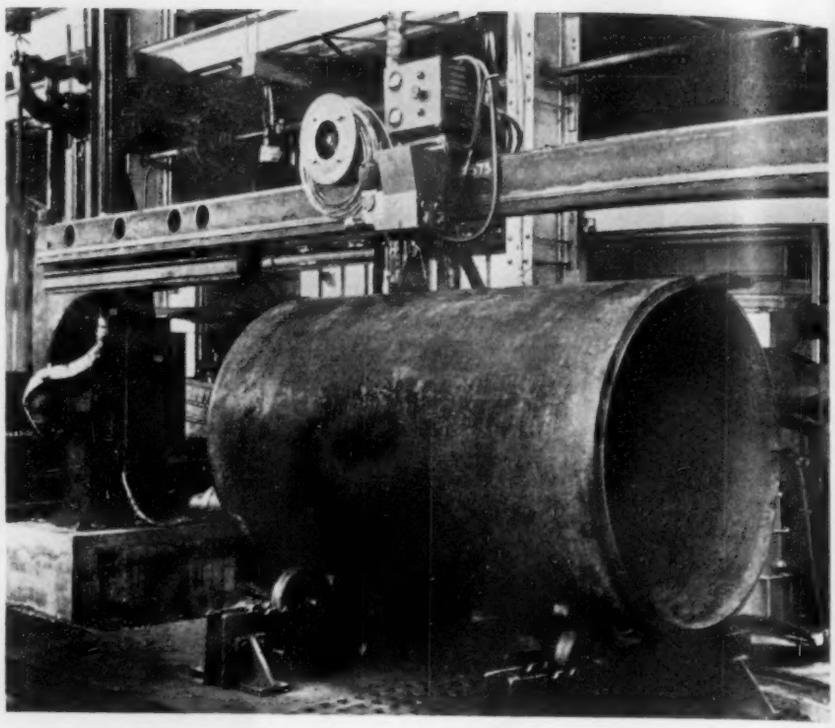


Fig. 1—Welding Longitudinal Seam by New "Lincolnweld" Process on Boiler Drum

The process is designed for use with direct current, utilizing a bare metallic electrode which is fed through a granular flux deposited on the joint to be welded. Sufficient flux is applied to completely blanket the arc and the molten metal; the unfused flux is then reclaimed for further use.

The manufacturers claim that direct current offers many important advantages over alternating current: such as a more simplified and positive control; ability

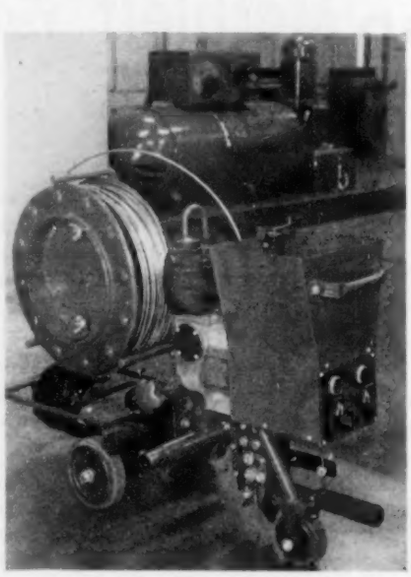


Fig. 2—"Lincolnweld" Unit of the Motor-Driven Tractor Type

to weld nonferrous materials; and better control of electrode melting rate through the option of either straight or reverse polarity.

Extremely high current densities are used. For example, $^{1}/_{8}$-in. diameter electrode may carry as much as 650 amp. This produces greater penetration and permits smaller cross-section of weld metal with resulting saving in cost and reduced warpage and distortion.

The exceptional quality of the welds produced by "Lincolnweld" automatic welding is indicated in the following table:

Material (as Welded)	Yield, Psi.	Tensile, Psi.	Ductility % Elong. in 2 In.
Low carbon steel such as Armco ingot iron	36,000	53,000	34
Medium carsteel such as ship plate	49,000	68,000	31
High carbon 0.40% steel such as gear bonsteel	64,000	87,000	24
Pressure vessel steel plate*	55,000	74,000	27

* Stress relieved at 1200° F.

The new process meets the welding codes, rules regulations and specifications sponsored by A.S.M.E. Power Boiler Code; A.P.I.-A.S.M.E. Unfired Pressure Vessel Code; Rules of American Bureau of Shipping; Lloyd's Register of Shipping Regulations; and the United States Maritime Commission.

The particular advantages reported for "Lincolnweld" are as follows:

First, one type and grade of flux, together with one analysis of electrode, can be used with the same procedure for a wide range of steel analyses. For example, ingot iron and steels up to 0.40% carbon can be welded with the same procedure. Thus, special joint preparation, changing of flux, wire analysis and welding procedure are elimi-

WHERE WELDS MUST BE RIGHT--Industry Depends Upon X-Ray

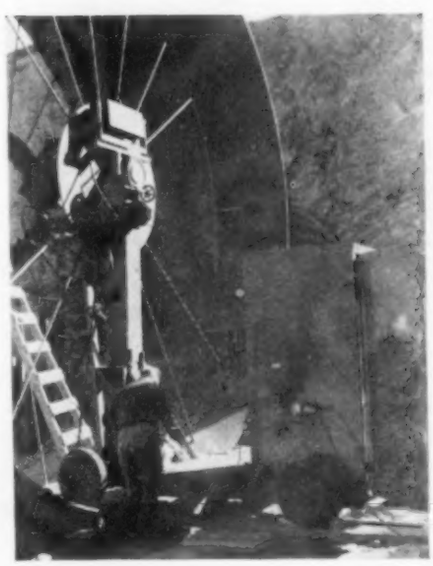
Parker Dam—Fontana Dam—Norris Dam . . . these great projects are just a few of many using penstocks and storage vessels built by the Chicago Bridge and Iron Company. During installation, every inch of weldment in these huge structures was x-ray inspected. Thus, their ability to resist the design pressures was insured.

Installation of four 22-foot penstocks at Parker Dam typifies procedures adopted by C. B. & I. on such projects. Materials pre-fabricated in their Chicago shops were shipped to the site. Here they were assembled, and all main seams possible were automatically welded. Then each welded seam was inspected by x-ray prior to placing the penstocks in their respective tunnels. Following the manual welding of the penstocks in place x-ray was again employed to insure proper connection strength. In all, over 7,000 4½ by 17-inch x-ray films were required to complete the job!

Though directly exposed to temperatures varying from 125 degrees to freezing—to excessive humidity and rainfall—the G-E X-Ray Unit used at Parker Dam never faltered! Such day-in-and-day-out dependability is characteristic of all G-E Industrial X-Ray apparatus.

G-E X-Ray offers a complete line of industrial units in a power range of 5,000 to 2,000,000 volts inclusive. A majority of industries engaged in welding depend upon G-E X-Ray inspection. You, too, will doubtless find one of these, shockproof, climate-proof, and 100% safe units the answer to many of your problems.

For complete details about the complete G-E Industrial X-Ray line—or to enlist the services of competent G-E industrial x-ray engineers in planning the application of x-ray in your industry—write or wire, today; to Department N84.



GENERAL ELECTRIC X-RAY CORPORATION
2012 JACKSON BLVD. CHICAGO (12), ILL., U. S. A.

1895 OUR FIFTIETH YEAR OF SERVICE 1945

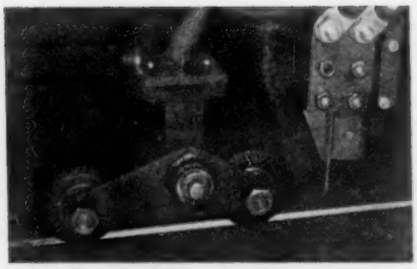


Fig. 3—Roller Guide for "Lincolnweld" Tractor Showing Rollers in Butt Joint of Work

nated, which is of tremendous importance to a manufacturer using automatic welding.

Second, the equipment will take 1/8-in. to 7/32-in. electrode without changes of drive rolls, wire contacts or control. The control is extremely simple and quick acting, there being no vibrating relays or electronic devices. The electrode will feed in either direction by means of the wire motor being controlled through a special exciter. This gives the operator quick and easy control over voltage, current and speed when changing from one job to another.

The welding head is normally used in conjunction with a specially built automatic welding set of 1200 amp. capacity. The current rheostat in the automatic control box permits a current range of 300 to 1200 amp. The unit has two exciters, one for the automatic head control and one for the welder field excitation. The welder control box has provisions for easy and quick wiring of the automatic.

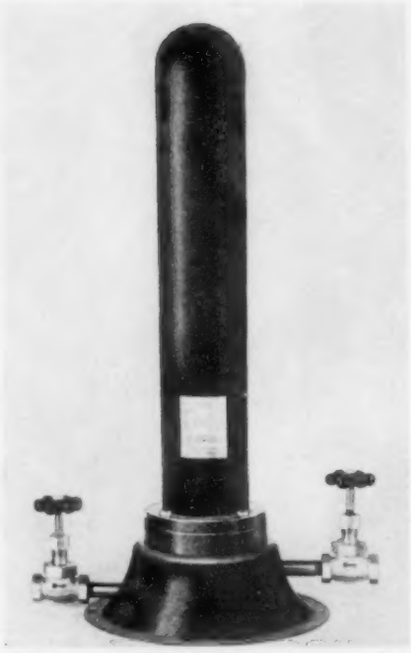
Figure 2 shows the welding head, with flux hopper, wire reel and control mounted on a motor-driven portable tractor unit. This has straight wire guide for butt welding. For square butt welding, a pointer is used for following irregular seams. For prepared joints, roller guides are provided for engaging the seam (see Fig. 3).

The standard head is changed from butt to fillet welding in a matter of only a few minutes. In making fillet welds the lower wire guide and flux tube are changed from straight to curved, thus permitting the head and wire reel to be left in its normal position. The wire is fed in at 40° from horizontal which gives the maximum effective throat for horizontal fillet welds.

GAS PURIFIER

A newly developed gas purifier utilizing the precious, but unrestricted, metal palladium as a catalyst that operates at room temperature and, together with a supplementary portable analyzer now being perfected, provides many war and other industries with "a new, efficient, inexpensive weapon to cut down waste and thereby speed up production" is announced by Baker & Company, Inc., refiners of precious metals, Newark, N. J.

Product of long research in the Baker laboratories, the company claims this new unit, named the Deoxo Gas Purifier, has shown in laboratory tests and also under practical working conditions its efficiency



in removing oxygen from such gases as hydrogen, nitrogen, argon and neon. Gases of extremely high purity, that is, with less than 20 parts of impurity in a million, are thus obtainable, it is claimed.

A.F.A. VOTES 1945 AWARDS

For distinctive contributions in the field of cast metals, the Board of Awards of the American Foundrymen's Association recently awarded gold medals and honorary life memberships in the Association to five outstanding leaders of the foundry field. Those honored, and the accompanying citations, are as follows:

To Robert E. Kennedy, Secretary, American Foundrymen's Association, the Joseph S. Seaman Gold Medal of A.F.A. "for outstanding meritorious service to all branches of the Foundry Industry through his work in organizing and guiding the development of technical and operating papers and discussions, and his untiring encouragement to all A.F.A. chapters, committees and members."

To C. E. Sims, Supervising Metallurgist, Battelle Memorial Institute, Columbus, Ohio, the John A. Penton Gold Medal of A.F.A. "because of his outstanding contribution to the Steel Casting Industry."

To M. J. Gregory, retired, Honorary Life Membership in A.F.A. "for his contribution to the Association and the Foundry Industry."

To Rear Admiral A. H. Van Keuren, U.S.N., Director, Naval Research Laboratory, Anacostia, D. C., Honorary Life Membership in A.F.A. "in recognition of his efforts in behalf of the Foundry Industry."

Honorary Life Memberships in A.F.A. were also awarded to Ralph J. Teetor, President, Cadillac Malleable Iron Co., Cadillac, Mich., President of the American Foundrymen's Association, 1944–45, and to R. E. Kennedy and C. E. Sims, the 1945 medalists.

SAMPSON HONORED

William J. Sampson, Jr., president of The American Welding & Manufacturing Company, Warren, Ohio, has been elected president of the Warren Chamber of Commerce. He has served on the Chamber's board of directors for the past year.

X-RAY AND RADIUM PROTECTION

Latest technical literature on X-ray and radium protection, together with lead products catalog, is available upon request to Bar-Ray Products, Inc., 209–25th St., Brooklyn 32, New York. Included with this material is the comprehensive data of the United States Bureau of Standards on X-ray protection which covers general recommendations, electrical protection, equipment, film storage and a wealth of other valuable information. Free upon request.

THE GUIDE 1945

The 23rd edition of the Heating Ventilating Air Conditioning Guide published by the American Society of Heating and Ventilating Engineers, 51 Madison Ave., New York 10, N. Y., is ready for engineers, architects, students, and the heating, ventilating and air conditioning industry.

A 15-page detailed index, a single page quick reference table of contents, and a brief summary of chapter contents under each chapter heading provide easy reference to the subjects treated in the book.

The Guide contains 48 chapters of technical data and information grouped under the general sub-divisions, Principles; Heating and Cooling Load Calculations; Combustion and Consumption of Fuels; Steam and Hot Water Heating; Air Heating, Cooling and Conditioning; Automatic Controls, Instruments and Motors; Special Applications and Miscellaneous. A change in format has increased the amount of text per page and consequently much useful information has been added.

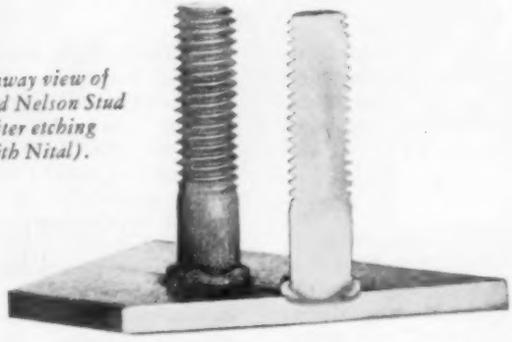
RADIANT HEATING SYSTEMS

That wrought iron pipe is the overwhelming choice for radiant heating systems in buildings ranging from monumental type structures to low-cost houses is revealed in the new handbook on "Radiant Heating," just issued by A. M. Byers Company, Pittsburgh.

Chief purpose of the 52-page book is to serve as a working manual both for the designer and the fabricator. Detailed procedure is listed for figuring heat losses and piping requirements, designing the coils, supply and return mains. Factual data is presented on the relative merits of locating the coils in the floor and ceiling. Included is a full page drawing of a floor-type radiant heating system for a representative industrial building in which both sinuous coils and grids are used to advantage.

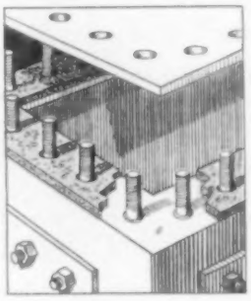
Tables are reproduced showing the heat transfer properties of various piping materials. There is also a section devoted to pipe bending and welding.

Here are a few of the ways thousands of Nelson Stud Welders are used . . .

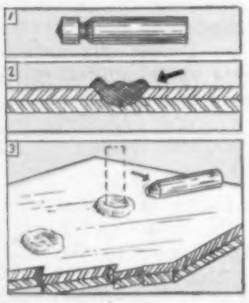


Cutaway view of welded Nelson Stud (after etching with Nital).

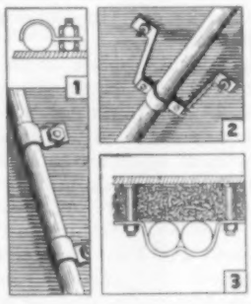
Thousands of Nelson Stud Welders are now used by more than 500 industrial plants and shipyards in applications similar to these. This process eliminates time and material consumed in hand-welding bolts, or drilling and tapping for studs. The *complete fusion* of the stud to metal is obtained *in ½ second* . . . and the resulting weld is stronger than the strength of the stud!



Inspection covers of all types can be secured with Nelson Studs. Eliminates drilling and tapping holes in the casing, or hand-welding studs. No leaking or loosening. Gaskets are placed over the studs and cover tightened down. Stud is welded in ½ second!



Plug welding is used to fasten light-gauge steel to structural steel or flat surfaces. Hole is punched in the top plate. Nelson Grooved Stud (1) is then welded through the hole to the bottom plate, fusing the two together (2). The stud is then broken off (3) and the weld bead is removed if desired.



Wiring, conduit, and pipe are quickly secured. Illustrated above are a few of the many methods used: 1. Securing conduit. 2. Securing pipe (single or multiple runs). 3. Securing wiring of all kinds over insulation materials.

For general maintenance of all kinds the Nelson Welder is excellent. It will end-weld studs to metal for any kind of repair. For securing oil lines, covers; hooks; wiring; nameplates; air lines; machinery installations; repairs; etc. It will be found that it is profitable to you both in the production line and for general work.

The Nelson Electric Arc Stud Welder

For complete details and catalog, write:

NELSON SPECIALTY WELDING EQUIPMENT CORPORATION

Dept. J, 440 Peralta Ave., San Leandro, Calif.

Eastern Representative: Camden Stud Welding Corp. Dept. 122, 1416 South Sixth St., Camden, N. J.

NELSON STUD WELDERS & STUDS

SECTION ACTIVITIES

BIRMINGHAM

On Thursday evening, March 1st, the Birmingham Section held one of their most interesting meetings. The meeting was attended by one of the largest gatherings of the season.

The speaker was T. B. Jefferson, Editor of *The Welding Engineer*, Chicago, Ill. His subject was "Welding in the Postwar World."

There was quite a lively discussion following the close of Mr. Jefferson's talk, and the discussions that followed were evidence of the interest created by the many phases of welding discussed.

BRUNSWICK

A meeting of the Brunswick Section was held at the Brunswick Country Club Thursday evening, March 1st.

After a delicious supper of shrimp and crabs with all the necessary trimmings there was a round-table discussion of the welding problems common to shipbuilding. It was both interesting and valuable.

R. M. Daniels, Lincoln Electric Co., Chattanooga, Tenn., was our guest and gave a very interesting informal talk on Welding Developments in 1944.

Members and guests present were 35.

CHATTANOOGA

The March meeting of the Chattanooga Section of the AMERICAN WELDING SOCIETY was held on March 2nd in the Banquet Room of the New China Restaurant. The speaker for the meeting was T. B. Jefferson, editor of *The Welding Engineer*, who spoke on "Welding in the Postwar World."

This subject struck a responsive chord to members of the Section and their friends because an unusually gratifying turnout was enjoyed. There were forty members and their guests for the dinner and about ten more were in attendance for the talk.

The Chattanooga Section was host to quite a number of visitors from as far away as Knoxville and Copperhill, Tenn., not to mention Eugene H. T. Chen of Chungking, China, who was sent here by his government for two years to study American methods.

An Office of War Information picture preceded the principal address and it was the consensus that this was one of our most successful meetings.

One very interesting added attraction was the reading of a letter from a member of the Chattanooga Section who is now in the South Pacific. This was a very interesting letter from Lt. Com. V. A. Cowart of the U. S. Navy and attached to USS *Ajax*. Com. Cowart's letter told of his work as a repair officer on one of the Navy Fleet Repair Ships. He told of how this vessel is literally a floating workshop and described the part that the oxyacetylene welding flame and electric arc "has played in our progress toward victory."

CHICAGO

W. A. Pearl of Whiting Corp. spoke on "Metallurgy and Welding of Dissimilar Metals" at the February 16th meeting of the Chicago Section. A Pre-Meeting Movie, entitled "Canadian Rockies," was shown through the courtesy of the Canadian Pacific Railroad. This was a technicolor of Lake Louise, Banff and Canadian Rocky Mountains. "Fishing Thrills" showed fresh-water fishing for muskies in the north woods; lake trout, black bass and deep sea fishing off the coast of Florida.

CLEVELAND

R. E. Lorentz, Jr., of Combustion Engineering Company in Chattanooga gave a fine talk at the March 14th meeting of the Cleveland Section on "Metallurgical Problems of Welding."

The educational program of the Cleveland Section has been progressing extremely well. The meetings have been enthusiastically attended and have been very educational according to all reports. The last meeting was held in the plant of the Reliance Electric & Engineering Co. where two men from The Lincoln Electric Co., E. Smith and John R. Morrill, discussed the new "Lincolnweld" process of automatic welding. Cal Wyss of Reliance then took the group on a tour of the plant, with special attention to the "Lincolnweld" installation for making Reliance generator frames and brackets.

The Cleveland Section inagurated for the first time in its history a permanent badge system for all members attending dinners and regular meetings, in an effort to broaden the acquaintanceship of all of the Section members. Growth of the Cleveland Section continues under the excellent leadership of Mike Shane, chairman of the membership committee, with eleven new names having been added during February.

COLUMBUS

The March 9th meeting held at the Southern Hotel was addressed by C. D. Steward of Curtiss-Wright, Buffalo, who spoke on "Multi Arc Welding of Aluminum Alloys."

DETROIT

The largest turnout in the history of the Detroit Section—more than 400 men and women—attended the annual Ford Motor Co. Welding Night on March 2nd at Fordson High School.

The technical speaker was Wm. J. Pfander, Ford chemical engineer, who spoke on "The Application of X-Ray to Welding for Quality Control." Mr. Pfander described typical and satisfactory welding installations, dwelling in detail on their effect on quality control. He pointed out that x-ray, properly supervised, uncovers such welding defects as inclusions, porosity, lack of penetration and lack of fusion. He made the point, also, that the presence of x-ray inspection equipment is a constant stimulant on welders to do their best work, because they know that internal defects will soon be showed up.

A coffee talk preceding the main paper was given by Wm. A. Simonds, Ford official, who described the history of the Willow Run Bomber plant. Preceding him, R. H. McCarroll, Ford executive engineer, welcomed the SOCIETY members and their guests, and bespoke company appreciation that Ford was invited to sponsor the program. Keith Sheren, designing engineer at Ford, was chairman of the event. Dinner was immediately followed by a varied musical entertainment put on by Ford employes.

INDIANA

P. M. LaHue of Westinghouse Electric & Mfg. Co. spoke on "Electronics and Their Application to Welding" at the February 23rd meeting of the Indiana Section held at the Riley Hotel, Indianapolis.

KANSAS CITY

J. E. Dado, process service supervisor for the Southwest Division of The Linde Air Products Co., addressed the February 20th meeting on "The Pressure Welding of Overland Pipe Lines." He explained the fundamentals involved and described the equipment and procedure developed for this type of welding. An excellent color film showing the fabrication of both an 8- and 16-in. gas line was presented. In the discussion following the talk, Mr. Dado showed sample welds and described other applications of pressure welding.

Two Army Air Force sound films were shown, "The Birth of the B-29 Superfortress" and "A.A.F. Report." Both were very interesting and it was decided to show at least one "War" film at each meeting.

LEHIGH VALLEY

The regular monthly meeting of the Lehigh Valley Section was held on Monday, March 5th, at the Hotel Bethlehem.

USE THESE RACO ELECTRODES
FOR SUPERIOR WELDING OF CORROSION- AND HEAT-RESISTING STEELS
RACOLLOY 18-8
For fine performance on these classes of steel: Unstabilized 18-8, Types 301, 302, 304, 306, 308. These electrodes are used for parts intended to resist relatively mild corrosive conditions in service, or for parts that can be heat treated after welding. For example, dairy, distillery and restaurant equipment, and chemical tanks.
WELDING CODES—Racolloy 18-8 electrodes meet requirements of U. S. Navy Bureau of Ships Specification 46E4 (INT) Grade I.
RACOLLOY 18-8Cb
These electrodes containing columbium are used with exceptional success for all-position welding of Types 321 and 347. Applications include welding stainless steel pressure vessels for continuous service in the temperature range of 700° —1600° F. These uses include chemical plant, oil refinery equipment and aircraft exhaust collector systems.
WELDING CODES—Racolloy 18-8Cb electrodes meet the requirements of U. S. Navy Specification 46E4 (INT) Grade II.
The REID-AVERY COMPANY
INCORPORATED
DUNDALK BALTIMORE 22 MARYLAND

The speaker of the evening, W. J. Conley of the Lincoln Electric Co., Cleveland, Ohio, spoke on "Mechanical Design for Welding." The talk which was illustrated with slides emphasized the elements of simplicity, flexibility and continuity in the welding design.

Mr. Conley predicted expanded applications of welding in the postwar period in the tank, building and bridge fields. Due to proper planning, the use of automatic welding will be greatly expanded. Mr. Conley also pointed out that the public's growing feeling of confidence in welding during the war will enhance the rate of acceptance of postwar welding.

The showing of the Harnischfeger Corp. sound film, "New Horizons in Welding" preceded the technical meeting.

LOS ANGELES

The February dinner meeting of the Los Angeles Section was held on the 15th, at Scully's Restaurant. Coffee talk for this evening was presented by Mr. A. Finlason, welding superintendent, Maywood Plant, The Consolidated Steel Corp. His subject was "Welding, the Key to Development of Steel Fabrication." Welding progress in fabricating shops was outlined from inception as a minor repair tool to its present predominance as the major method for uniting metals.

Principal speaker was M. H. MacKusick, welding engineer, The California Shipbuilding Corp. The title of his presentation was "Technical Control of Welding in Ship Construction." He outlined welding procedure and their control methods employed. Statistical tables and subassembly practices were shown on a series of slides.

Showing of the film "New Horizons in Welding" concluded the program.

The first field trip of the year was made the evening of February 22nd. It consisted of a tour through the Kaiser Steel Mill at Fontana. The maximum allowable group of 200 was afforded an enjoyable and educational evening as guests of the management.

LOUISVILLE

At our dinner meeting on February 27th the Louisville Section was honored by the presence of our National President, A. C. Weigel, of New York City. The attendance of 135 members and guests really turned out despite inclement weather and threatening "flood stages" of the Ohio River which naturally upset things considerably. However, Mr. Weigel was enthusiastically received and the meeting made "Homey" (so to speak) as the assemblage burst into song—"Happy welcome, Dear Al-L-L, happy welcome to you." His topics covered a wide range, displaying a fertile mind and a wealth of knowledge characterized by a homely philosophy that hit deep and brought the belly-laughs. "THE WELDING SOCIETY as a whole" was "the favorite child of a proud daddy" and he accentuated the good points as every good father should.

C. J. Burch of Linde Air's Development Laboratory presented "Pressure Welding by the Oxyacetylene Process," with appropriate slides, which re-emphasized his points and, "as proof of the pudding, etc.," innumerable questions were asked with a corresponding answer in matter-of-fact language and not too technical.

R. E. Fritsch, President of Tube Turns, Inc., our master of ceremonies (incidentally of master of procedure), was at his best in performance and, with a degree of showmanship ever present, he did an excellent job.

T. H. Lewis, Louisville Section Chairman, was characterized as being the hardest working chairman which is a prerequisite in any language for S-U-C-C-E-S-S. New innovations are proving an "attendance-getter" and, after all, the box office talks. Both Mr. Weigel and Mr. Burch qualified for a "Certificate of Appreciation" appropriately framed for wall decoration and delivered by Mr. Lewis.

MARYLAND

The February meeting held on the 16th was one of the outstanding of the season. The Section was fortunate in having Wendall F. Hess, of R.P.I., as their speaker and obtaining a more intimate picture of the type of work he does.

His discussion presented the methods and results obtained in his work with high carbon steels as joined in resistance welding. The question period kept Dr. Hess quite busy. During this time, he also gave a brief review of his work in cleaning aluminum for spot welding.

Dr. Hess's simple, straightforward, but effective presentation proved both informative and enjoyable.

MICHIANA

The Michiana Section announces the election of the following officers:

Chairman, W. G. Fassnacht, Bendix Products Division; *Vice-Chairman*, W. A. Gage, Edwards Iron Works; *Secretary-Treasurer*, G. C. Hill, Carnegie Illinois Steel.

Executive Committee: George La Bar, Bendix Products Div.; Stanley Kromkoski, Edwards Iron Works; C. A. Weir, Dodge Mfg. Co.; E. T. Davis, Indiana & Michigan Electric Co.; Geo. Mittler, The Linde Air Products Co.; Victor Henry, Bendix Products Div.

The Michiana Section has held the following meetings:

October—Frank Thompson, "Underwater Cutting and Welding."

November—General Electric Co.'s films on A. C. Welding, with questions answered by L. G. Pickhaver.

December—Mr. Eric Seabloom of the Crane Co., "Fusion Welding in Pressure Piping."

January—T. B. Jefferson, Editor, *The Welding Engineer*, "Welding in the Postwar World."

February—A. E. Ziesel of the Eutectic Welding Alloys Co., "The Eutectic Welding Process," with actual demonstrations.

March 23rd—A. P. Himes of the Indiana and Michigan Electric Co., "Welding Hydroelectric Equipment."

MILWAUKEE

Walter J. Brooking, Director of Testing and Research of R. G. LeTourneau, Inc., Peoria, Ill., was the speaker at the February 23rd meeting held at the Ambassador Hotel. Dr. Brooking spoke on "The Welding Engineer's Job."

NEW JERSEY

The regular monthly meeting of this Section was held on March 20th at the Essex House, Newark. C. Hansen of the Foster Wheeler Corp., Carteret, N. J., conducted the "Information Please Session."

The speaker of the evening was E. Kelly, of the Haynes Stellite Co., New York, who spoke on "Hard-Facing in the War on Wear."

NEW YORK

For its February meeting, the New York Section was the guest of the New York Metropolitan Section of the Society of Naval Architects & Marine Engineers at the Downtown Athletic Club. Approximately 400 people attended the meeting following a dinner also held at the Club.

At this meeting two papers were presented. The first was by E. J. Charlton, Assistant to the President, Lukenweld, Inc., who talked on the fundamental principles upon which the decision to use welded construction is based. His talk was well illustrated with slides from the ship building industry as well as other industries, each selected for demonstrating a particular point. Mr. Charlton's talk provoked an animated discussion.

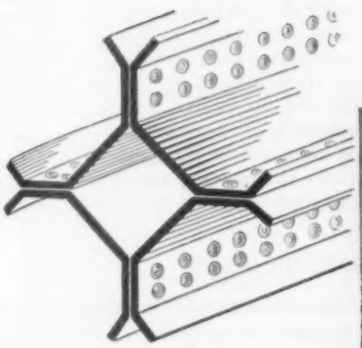
A second paper was presented by J. H. Deppeler, chief engineer, Metal & Thermit Corp., who followed an outline of the principles of thermit welding with a discussion on the use of this process for fabrication of stern frames. Mr. Deppeler also showed a colored motion picture of this application of the process in an East coast yard.

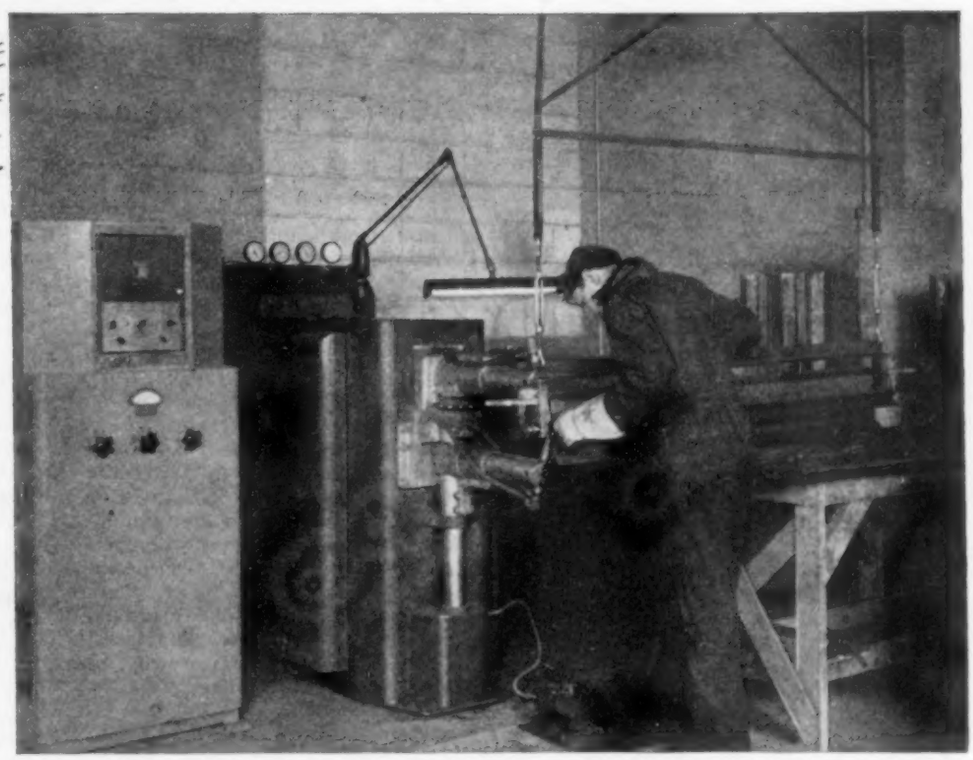
As was pointed out at the meeting, one does not think very long today about ships and ship construction without giving serious consideration to the subject of welding and, conversely, it is a superficial consideration of the subject of welding that does not bring one into close contact with its applications in ship construction.

The regular monthly technical meeting of the New York Section was held on Tuesday, March 13th, at the Engineering Societies Building. J. A. Cahill, N. Y. Navy Yard, Brooklyn, presided as chairman for the evening.

The speaker for this meeting was Howard Hughey, Air Reduction Sales Co., who spoke in the absence of A. H. Yoch also of the Air Reduction Sales Co. Mr. Hughey talked on "Multiple Stack Machine Cutting." He described the techniques used in ordnance plants, shipyards and other shops that fabricate steel, and explained the rapid strides made in recent years with multiple cutting and stack cutting. He also pointed out how the war has revived interest in the oxyacetylene cutting of many similar parts

Quarter-inch-steel welds on 26.7 KVA (maximum demand)





Right: PROGRESSIVE Battery Welder, with mono-rail quick-clamp fixture, making 1/4 inch thick welds in structural steel at the rate of 29,000 every 20 hours, on a maximum input of 26.7 KVA.

and 29,000 Spots per day

The job was to produce fluted structural parts for an ordnance job of 1/8 inch thick steel stampings. Specifications called for 240 welds per unit—1/4 inch total thickness.

It would have taken 150 KVA A-C demand to do this job, but that much power was not readily available.

The answer was a PROGRESSIVE BATTERY WELDER. (Shown above). That welder with only 12 battery cells has been running 20 hours per day, turning out 6 assemblies per hour. The batteries are kept charged by a charger operating from a 220 volt line. Maximum recorded draw of this charger is 70 amps. per phase—a peak of 26.7 KVA—an amount of power that can be handled by ordinary shop wiring, eliminating bus bars, etc.

In addition, the BATTERY WELDER is producing a better job. Control is easier, induction losses are reduced.

For the story of "How and Why of Battery Welding", write for booklet #902.

PROGRESSIVE WELDER CO.

SEAM PROJECTION & BUTT • *Electric Welding Equipment* • PORTABLE GUN & PEDESTAL

3050 E. OUTER DRIVE • DETROIT 12, U. S. A.

at one time. The talk was well illustrated with numerous lantern slides of typical applications of multiple stack cutting.

Prior to the technical meeting, a half-hour question and answer session was conducted by Mr. E. V. David, Air Reduction Sales Co.

NORTHERN NEW YORK

The March meeting, held on the 1st at the Van Curler Hotel, Schenectady, N. Y., was addressed by J. M. Diebold of General Motors Corp., on "The Duck." A film, "Truck Ahoy," was presented in connection with the paper.

NORTHWEST

"Arc Welding as Applied to the Building of Heavy Equipment," illustrated with lantern slides, was presented by Elmer Isgren, Plant Manager of R. G. LeTourneau, Inc., Peoria, Ill., at the March 8th meeting held in the Men's Lounge, Coffman Memorial Union, U. of M.

OKLAHOMA CITY

The regular monthly meeting was held on February 22nd at the Biltmore Hotel. Mr. F. C. Fantz, Vice-President of Midwest Piping & Supply Co., St. Louis, Mo., spoke on "Design for High Pressure-High Temperature Alloy Steel Pipe Welding."

PEORIA

The annual business meeting of the Peoria Section was a dinner meeting held on Feb. 14th, at the Hotel Jefferson with some 60 members and guests attending.

The main address was given by Walter J. Brooking, retiring chairman, and consisted of a report to the Section and a résumé of the past year's activities, together with a forecast of the coming year. Membership of this Section has increased between 30 and 40% in the past year in spite of the fact that a large number of the eligible prospects and active members are in the Armed Forces and away from the community. The prospects for the coming year are even brighter due to the energetic efforts of the membership committee and the attractive programs, which have been presented in past years.

The February meeting, which was the annual joint dinner meeting with the American Society for Metals, was addressed by W. J. Brooking of R. G. LeTourneau, Inc., and the subject was "The Fundamentals of Welding."

The subject of shipbuilding was covered very ably by L. C. Stiles, Chicago Bridge & Iron Co., who addressed the Section on the subject "Welding of LST Landing Craft."

The following officers have been elected: *Chairman*, Alfred A. Wald, Caterpillar Tractor Co.; *Vice-Chairman*, Harold Baldwin, R. G. LeTourneau, Inc.; *Secretary*, Franklin Watkins, R. G. LeTourneau, Inc.; *Treasurer*, John Hanley, A. Lucas & Sons.

Executive Committee: Kenneth Jackson, Caterpillar Tractor Co.; Lyle Bibb, R. G. LeTourneau, Inc.; Walter J. Brooking, R. G. LeTourneau, Inc.

Directors: L. W. O'Day, Lincoln Electric Co.; Herman Moyer, R. G. LeTourneau, Inc.; Edwin Schmidt, Keystone Steel & Wire Co.

PHILADELPHIA

Sponsored by the Philadelphia Chapter, American Society for Metals, with the cooperation of the Philadelphia Section, A.W.S., another course is being given at Temple University, 1827 N. Broad St., Philadelphia 22, starting Monday, March 5, 7:30 P.M. at Thatcher Hall, cor. Park Ave. & Norris St. The course is on Metallurgy of Welding for engineers, welders, supervisors, designers, inspectors. Lectures and discussions by recognized authorities. Wednesdays, 8:00 to 10:00 P.M. for 15 weeks, including: Manufacture of Iron and Steel, Physical Properties, Freezing of Metals and Alloys, Constitution Diagrams, Critical Points, Microstructures of Welds, Effect of Heating and Cooling Rates, Welding Processes, Fluxes, Rods, Coatings, Heat Treatment of Welded Structures, Welding of Alloy Steels, etc.

Laboratory work in a fully equipped lab. Mondays, 7:30 to 10:30 P.M., for 15 weeks, including, Welding Process Demonstrations, Tensile, Hardness, Bend and Nick-Break Testing of Welded Specimens, Deep Etching and Sulphur Printing of Welds, Microscopic Examination, Photomicrography, Determination of Critical Points of Steel, Heat Treatment of Welds, etc. Tuition is $25, including lectures and laboratory.

The regular meeting held on February 19th at the Engineers' Club, was addressed by Norman Mochel of Westinghouse Electric & Mfg. Co., who spoke on "Castings in Large Weldments."

PITTSBURGH

Nearly 100 members and guests attending the February 21st meeting to hear an exceptionally interesting discussion on the "Welding of Copper and Copper Alloys" by J. J. Vreeland, Metallurgical Engineer, Sales Promotion Div. of Chase Brass and Copper Co., Waterbury, Conn. His discussion covered the welding of copper and copper alloys both by the carbon arc and oxyacetylene methods. With the use of slides and charts to illustrate his talk Mr. Vreeland kept the interest of those present at a high pitch throughout. Following the talk the meeting was thrown open for discussion.

PORTLAND, MAINE

Two very successful meetings were held in January and February. The January meeting held on the 30th was addressed by E. H. Turnock of Westinghouse, who spoke on "Electrodes." A film, Part II, "Steel for the Armed Forces," rounded out the evening program.

Robert T. Young, Principal Surveyor of the American Bureau of Shipping at the New England Shipbuilding Corp., So. Portland, was the speaker at the February 27th meeting. Mr. Young's subject was "Strength in Welded Ships."

PUGET SOUND

The February 21st meeting was held at the Mayflower Hotel, Seattle, Wash. Joe Holt, Webster Brinkley Co., conducted the question box discussion. James C. Cox, production manager of the S-M-S Corp. of Detroit, spoke on "Resistance Welding" and also showed a Navy film on Aircraft Welding, which he incorporated with his talk.

ROCHESTER

The March meeting was held at the University of Rochester on the 1st. G. N. Sieger of S-M-S Corp., Detroit, spoke on "Resistance Welding." Mr. Sieger covered the fundamentals of resistance welding that is often overlooked. He answered many questions and all members present felt that their knowledge of resistance welding had been greatly enhanced.

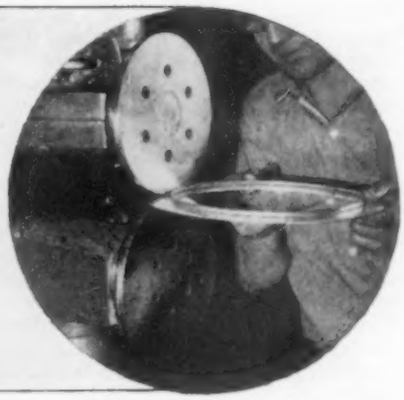
Among other guests were Don Patterson, Past Secretary of the Buffalo Section, and Harold Beasley, also from Buffalo.

SAINT LOUIS

Joint meeting with the Engineers' Club was held on February 15th. This was an all-discussion meeting from the floor on "Welding and Cutting" and was led by F. C. Fantz, Vice-President, Midwest Piping & Supply Co. Discussion panel consisted of W. S. Evans, Curtiss-Wright Corp.; C. H. Jennings, Westinghouse Electric & Mfg. Co., and J. F. Franzen, Air Reduction Sales Co. For several years this Section has sponsored at least

Peoria Section Officers. Front Row (Left to Right). John Hanley, Treasurer; Harold Baldwin, Vice-Chairman; Walter Brooking, Retiring Chairman; Alfred A. Wald, Chairman; Franklin Watkins, Secretary. Standing (Left to Right) Clifford Wimmer, Past Chairman; Edwin Schmidt, Director; Lyle Bibb, Executive Committee; Larry O'Day, Director; Herman Moyer, Director; Kenny Jackson, Executive Committee.

DO'S *and* DON'TS
for
Resistance Welding Timing Equipment



Do's

1. Use suitable automatic current timing devices.
2. Use electronic or magnetic welding contactors developed specifically for welding applications.
3. Have all timing devices suitably calibrated.
4. Use synchronous electronic timing controls for short timing periods or in welding materials having critical weldability.
5. Provide suitable mounting of timing devices to protect them from vibration, abuse, excessive heat or dirt and for ready servicing.
6. In all seam welding applications, use synchronous controls, providing interrupted timing periods.
7. When using an Ignitron control with a welder drawing less than 40 amperes from the line, provide a load resistor across the primary so that the current does not fall below 40 amperes.
8. Keep all electrical contacts in relays, switches and contactors in good condition by frequent inspection and dressing, or replacement if necessary.

Don'ts

1. Avoid using slow operating magnetic contactors for a welding contactor, if you are doing precision work.
2. Never use non-synchronous timing devices for short timing (less than 4 or 5 cycles).
3. Do not employ non-synchronous timing devices for welding materials with critical welding characteristics, such as aluminum, magnesium and brass.
4. Avoid expensive synchronous timing devices for long timing, non-critical applications.
5. Don't use welding contactors or Ignitron controls, the capacity of which is not equal to the rating of the welding machine and duty cycle of the application.
6. Never operate a synchronous Ignitron control with the secondary of the welder open circuited unless a 40 ampere load resistor is provided.
7. Don't expect the timer to operate satisfactorily if the limit relay or switch in the timer-welder circuit chatters, or the contacts are oxidized or pitted.
8. Do not expect the timer to provide uniform timing pulses if the primary voltage regulation is poor (ascertain timer manufacturer's recommended limits of voltage variation).

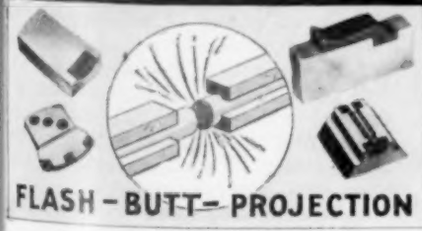
DO increase output by using Mallory Standard Resistance Welding Electrodes—spot welding tips and holders. Consult us for seam welding wheels, flash, butt and projection welding dies for your particular application. Write for your copy of the electrode catalog and the Mallory Resistance Welding Data Book, sent gratis to resistance welding engineers when requested on company letterhead.

One of a series—the entire series mailed at your request.

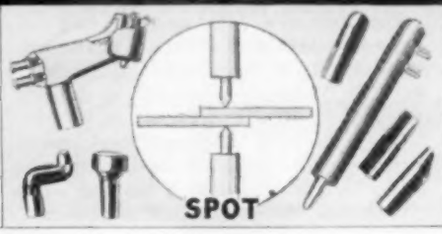
P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

P. R. MALLORY & CO. Inc

MALLORY *Standard Resistance Welding Electrodes*



FLASH – BUTT – PROJECTION



SPOT

SEAM

one meeting of this kind each year, and every year its success increases. There were 350 members and guests present. A Pre-Meeting Movie, "Yankee Noodle," was shown.

SYRACUSE

The March meeting of the Syracuse Section was held on the 8th at the Syracuse Museum of Fine Arts. J. J. Vreeland of Chase Brass & Copper Co. gave a very good paper on "Welding of Copper and Copper Alloys." This was illustrated with numerous slides and after Mr. Vreeland finished speaking, there was a lively discussion period.

Tentative plans for the annual meeting of this Section in May are under way, consisting of a dinner to be held at the Hotel Syracuse and installation of newly elected officers.

TIDEWATER

The regular monthly meeting of the Tidewater Section was held Tuesday, Feb. 13, 1945, at 8:00 P.M., in the Fleet Reserve Hall, 305 High St., Portsmouth, Va.

The meeting was called to order by the chairman, C. O. Barham, who then appointed a nominating committee, to select names of members of the section, to be placed for nomination for offices to be filled, in the section for the coming year. The committee appointed was as follows: Hal R. Fields, P. C. Greene, E. S. Nauce, R. S. White and A. C. Love. The committee is to submit to the Section at the next meeting, list of names nominated for offices.

The speaker, W. J. Conley, a distinguished figure in the engineering field and consulting engineer for the Lincoln Electric Co., was then introduced by the chairman.

Mr. Conley gave a splendid lecture on the subject, "Mechanical Designs for Welding," which was accompanied by slides, illustrating the many and various designs for welding. After the lecture, Mr. Conley retained the floor, for discussions, and very instructively answered the many questions asked, pertaining to welding.

The meeting was adjourned, and light refreshments were served. Approximately forty (40) members were present.

The following monthly meetings and speakers will be held by the Tidewater section in the Fleet Reserve Hall, 305 High St., Portsmouth, Va. at 8:00 P.M. (second Tuesdays).

April 10th: T. R. Lightenwater, speaker, Republic Steel Co., Massillian, Ohio.

May 8th: Clinton E. Swift, speaker, Eutectic Welding Alloy Co., N. Y. Subject: "Low-Temperature Welding."

TOLEDO

The February 13th meeting had to be moved ahead one week on short notice, so as to give the members a chance to attend the Toledo Technical Council meeting, which fell on the regular meeting date of the Toledo Section. Walter F. Benning, Chassis Engineer, Willys-Overland Motors, Inc., talked on the "Future of the Jeep," and a color film brought out more information about this unusual vehicle.

The members of the A.I.E.E. were invited to be present at this meeting as the subject was "Resistance Welding" which they would be interested in.

Charles W. Dodge, Research Engineer of Sciaky Brothers, Chicago, gave an explanatory lecture on welding of aluminum and steel by the resistance method.

The special guest, J. F. Maine, Chief Engineer, Republic Structural Iron Works, Cleveland, and Vice-President of the 4th District, A.W.S., answered many directed questions.

Two short films, "Battle Wreckage" and "Captured German War Film," topped a worth-while evening.

WESTERN MICHIGAN

E. J. Tompkins, Chief Metallurgical Engineer for Central Steel & Wire Co., Chicago, spoke on the subject "Changes in Material Specifications for Specific End Uses from Pre-War Materials That Have Been Effected by Developments During the War Period," at the February 26th meeting of this Section. A color motion picture, showing iron ore from the mine to the completed product, was shown through the courtesy of the Carnegie-Illinois Steel Co.

WESTERN NEW YORK

Charles H. Jennings of the Westinghouse Electric & Mfg. Co. spoke on "Practical Phases of Welding Design" at the January 22nd meeting held at the Forty & Eight Club.

WICHITA

The February meeting of the Wichita Section was held in the Rose Room of the Broadview Hotel on Wednesday, Feb. 21st. Our speaker for the evening was F. C. Fantz, Vice-President of Midwest Piping & Supply Co., St. Louis, Mo. Mr. Fantz started the evening by telling something about each type of welding. Several questions were asked and this led to several discussions. Mr. Fantz is a good authority on welding and was able to give a good answer to each question asked. His subject for the evening was "Design for High Pressure-High Temperature Alloy Steel Pipe Welding." Mr. Fantz has had considerable experience with the various alloys and gave some very interesting information concerning them. His talk was accompanied by slides which made the meeting very interesting.

The last item on the program for the evening was a 35-minute sound film furnished by the Army Air Force.

YORK-CENTRAL PENNSYLVANIA

The February 14th meeting was addressed by Arthur A. Holzbaur of the Sun Ship-building & Dry Dock Co., Chester, Pa. Mr. Holzbaur spoke on the subject, "Welded Ship Construction."

E. J. Charlton, Manager, Development Engineering for Lukens Steel Co., was the speaker at the March 14th meeting. His subject was "Conversion to Welded Steel."

The April 11th meeting will be an Annual Meeting and Dinner and will be held at the Valencia Ballroom. This night has been set aside as Ladies' Night. The General Electric Co. will exhibit and explain their "House of Magic." Meeting will start at 7 P.M.

The May 9th meeting will be a Coatesville meeting for members only.

Employment Service Bulletin

POSITIONS VACANT

V-156. Welding Foreman. Man experienced in gas and atomic hydrogen welding of stainless steel. Applicant must be capable of assuming full supervision and have the ability to instruct Welder-Trainees.

V-157. Welding Sales Engineer: Large manufacturer of nonferrous welding electrodes requires the services of a sales engineer with welding and engineering background to handle technical sales correspondence, demonstrate and contact distributors. Good starting salary. Permanent connection with nationally known organization. WMC rules apply.

V-158. Welder Foreman. Experienced man thoroughly familiar with acetylene welding of carbon steel and stainless steel sheet metal parts for aircraft. Must have proved supervisory experience and capable of instructing welder-trainees. Write giving full particulars as to age, experience and salary desired.

V-159. Salesman—To sell brazing, hard soldering fluxes and electroplating specialties for progressive manufacturer in Metropolitan area of New York City and Newark. Salary, commission and bonus.

SERVICES AVAILABLE

A-487. Welding Metallurgist desires position. Age 27, single. Graduate B.S. Met. Eng. 1939. Graduate work in Metallurgy. Has been successfully employed in Metallurgical Research and Development work since 1940. Present position testing and research work on arc-welding electrodes.

A-494. Operator, 5 years' experience, Arc and Gas, familiar with hard-soldering, brazing, stainless, production work only. Especially experienced on pressure proof tested sheet metal boxes and housings. Operates lathe and shaper, can make simple jigs. Can assist general foreman in taking supervision of medium welding department, New York City and vicinity.

A-495. Welding engineer who has theoretical training and practical experience in all phases of welding. Has a thorough knowledge of welding costs, sales and management. Specialized the past year on Resistance Welding methods, design and application. Will consider position as Welding Engineer, Welding equipment or supplies sales, or as shop superintendent in charge of all welding.

A-496. Welding Engineer; 10 years as

NOW...you can Increase Production

with CESCO's New Air-Flow Welding Helmets

• Welders wearing CESCO's new *Air-Flow* Helmets stay at their jobs in comfort, under any conditions. Tests in many large plants have proved that production is increased as a result.

CESCO's advanced method of helmet "air-conditioning" washes away fumes and heat . . . reduces worker fatigue. Fresh air is ingeniously supplied by a new, exclusive system of air feeding.

Doctors and safety engineers designed . . . and strongly recommend . . . the new CESCO *Air-Flow* Helmet. Workers welcome it . . . never before have they been assured such safety, comfort and health protection.

CHICAGO EYE SHIELD CO.
2332 WARREN BOULEVARD, CHICAGO 12, ILLINOIS

Get the facts... FREE
Write for this new, illustrated CESCO booklet *TODAY*

CESCO

CESCO FOR SAFETY

Welding Engineer. 21 years Railroad experience. Experienced on production of all-welded pressure vessels, locomotive boiler shell, gun carriages, Diesel engine frames, heat exchangers etc. Materials of mild, low and high strength alloy, stainless and chrome steels, copper and copper alloys. X-ray work. Knows welding codes, Army and Navy Spec's. Experienced in Union-Melt, General Electric and Lincoln Automatic operation. Graduate M.E. Knows Physical Metallurgy.

Thirty years' service with two large corporations. Member A.W.S. Available immediately. Desires permanent position with railroad or welding concern who can eventually employ this varied experience to fullest extent.

List of New Members

February 1 to February 28, 1945

BIRMINGHAM

Duggan, Claude (B), Menefee & Elliott Engrs., 18 Steiner Bldg., Birmingham, Ala.

BOSTON

Fluke, W. E. (B), 292 Main St., Cambridge 42, Mass.
Wise, Frederick R. L. (B), S. D. Hicks Eng. Co., 1671 Hyde Park Ave., Hyde Park Dist., Boston, Mass.

BRUNSWICK, GA.

Beall, Paul N. (B), Hotel Willetta, Brunswick, Ga.
McDonald, E. O. (B), W. A. 24, Apt. 174, Brunswick, Ga.

CANTON

Davidson, Kenneth B. (C), 809 Third St., S. W., Canton 4, Ohio.

CHICAGO

DuVal, Lark Edw. (C), 1104 West 103d Pl., Chicago 43, Ill.
Kirtley, Edw. M. (B), Mid-States Equipment Co., 2429 S. Michigan Ave., Chicago 16, Ill.
Reed, Walter E. (B), 320 Oakland Dr., Highland Park, Ill.
Sima, Henry (C). 2834 So. Kostner Ave., Chicago 23, Ill.

CINCINNATI

Lewin, Gus (C), 4312 Watterson St., Cincinnati 27, Ohio.

CLEVELAND

Luebbert, H. F. (C), Stadium Boat Wks., Ft. of W. 3rd St., Cleveland 13, Ohio,
Pracker, Arthur W. (C), 1370 W. 114th St., Cleveland, Ohio.
Silverman, Irving (C), 2196 Delaware Dr., Cleveland Hts., Ohio.
Truden, F. A. (B), Consolidated Vultee Aircraft Corp., Nashville Div., Nashville, Tenn.
Whitney, Robt. C. (C), 1264 E. 115 St., Cleveland, Ohio.

DETROIT

Chin, Capt. Chia Tao (B), Y.M.C.A., Flint, Mich.
Hannan, Lawrence E. (C), Square D Co., 6060 Rivard, Detroit 11, Mich.
Kohler, Theodor (C), 19349 Kelly Rd., Detroit, Mich.

HARTFORD

Zenczak, Stephen A. (B), 148 Madison Ave., Hartford 6, Conn.

INDIANA

Condon, Herbert F. (B), Anderson, Ind.
Zietlow, Lt. F. P., (B) U.S.N.R. Production Div., Puget Sound, N. Y., Bremerton, Wash.

LEHIGH VALLEY

Jenny, Cletus J. (C), 7 Clay St., Delawanna, N. J.

LOS ANGELES

Baldwin, John W. (C), 2927 Altura St., Los Angeles 31, Calif.
Converse, Paul L. (C), 1834 Stoner Ave., West Los Angeles 25, Calif.
Grohs, Fred (C), Victor Equipment Co., 3821 Santa Fe Ave., Los Angeles 11, Calif.
Nadgwick, L. W. (C), 12013-4 E. 61 St., Los Angeles 1, Calif.
Simmons, Edw. E., Jr. (C), 455 S. Oakland Ave., Pasadena 5, Calif.

LOUISIANA

McKinstry, W. B. (B), American Bureau of Shipping, 1413 Hibernia Bank Bldg., New Orleans, La.

MARYLAND

Wallace, Wm. B. (C), 1132 Bonsal St., Baltimore 24, Md.
Whiting, Geo. Wm. C. (C), The Whiting Turner Contracting Co., 305 National Marine Bank Bldg., Baltimore 2, Md.
Wingert, Donald E. (B), 14 Seabright Ave., Baltimore 22, Md.

MICHIANA

Abair, G. H. (C), R. R. 4, Niles, Mich.
Heuck, Raymond (C), 2718 Hartzes St., So. Bend, Ind.
Mittler, Geo. W. (C), 1323 E. South St., So. Bend 15, Ind.
Van Lopik, C. E., (C), 124 L W E, So. Bend 6, Ind.

NEW JERSEY

Berezney, Michael (C), 2718 Bainbridge Ave., Bronx, N. Y.
Butler, Laurence B. (C), 92 W. 33d St., Bayonne, N. J.
Cashmore, C. Ernest (B), 819 Walnut St., Roselle Park, N. J.
Corley, Joseph M. (B), 25 S. Oraton Pkwy., East Orange, N. J.
Dawkins, Harry C. (B), Tidewater Assoc. Oil Co., Ft. 22d St., Bayonne, N. J.
Dugan, Stephen P. (C), 403 Walnut St., Newark, N. J.
Jackel, H. A. (C), General Engrg. Co., 65-67 N. Ninth St., Paterson, N. J.
Jones, Earl C. (C), 500 Haddon Ave., Camden, N. J.
Krol, Peter F. (B), 16 Doering Way, Cranford, N. J.
Lewis, Henry S. (B), Manning Welding & Eng. Co., 30 Ogden St., Newark, N. J.
Lindstrom, Harvey V. (C), 10 Van Housten Ave., Jersey City, N. J.
Lundelius, A. (B), Metalsmiths, Div. Orange Roller Brg. Co., 557 Main St., Orange, N. J.
McAvoy, David (C), American Metal Co., 247 Verona Ave., Newark 16, N. J.
McCaffrey, Raymond J. (B), 719 Blvd., Bayonne, N. J.
Mielozarski, Chester C. (C), 69 Claremont Ave., Jersey City 5, N. J.
Miller, Frederick (C), 363 Ocean Ave., Jersey City, N. J.
Mooney, Gerard P. (C), 537 S. Broad St., Elizabeth, N. J.
Safko, Frank A. (C), 790 Carson St., Hazleton, Pa.
Schwahl, Edw. (C), 9—4th St., N. Arlington, N. J.
Speizio, Mario F. (C), 484 Ave. A, Bayonne, N. J.
Transou, Adam J. (B), c/o Engr. Dept., Tide Water Assoc. Co., E. 22nd St., Bayonne, N. J.

NEW YORK

Humphrey, Stanley M. (B), 55 Trumbull Rd., Manhasset, L. I., N. Y.
McArthur, Walter E. (C), Atlantic Specialties Co., RM. 2512, 220 E. 42nd St., New York 17, N. Y.
Oster, Harold F. H. (C), 58 Wall St., Farmingdale, N. Y.
Reade, Vincent J., Jr. (B), c/o Whitehead Metal Products Co., Inc., 303 W. 10th St., New York, N. Y.

NORTHERN NEW YORK

Nippes, Dr. E. F. (C), Rensselaer Polytechnic Institute, Troy, N. Y.

NORTHWEST

Garowsky, Dan (C), 1159 E. Jenks Ave., St. Paul 6, Minn.
King, Phillip A. (C), 575 Cromwell Ave., St. Paul 4, Minn.
Lofstrand, Wilton S. (C), 4839 Fremont Ave. N., Minneapolis 12, Minn.
Lundberg, Milton A. (C), 5232—46th Ave. S., Minneapolis 6, Minn.

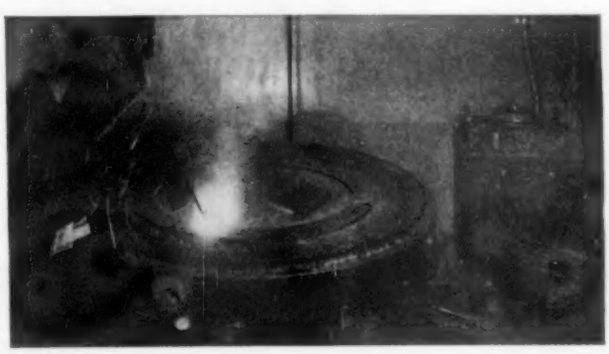
A-C WELDING Helps "Keep 'em Rolling" on Rubber...

From jeep to 20-ton tank retriever, America's army rolls on rubber. Tire "casualty rates" in battle have strained tire manufacturing facilities to the limit, and many a vital transportation battle at home and abroad would have been lost if repairing, recapping and retreading equipment had not been instantly available.

Supplying such equipment is the job of the Bacon Vulcanizer Manufacturing Company of Oakland, California. With welded fabrication neatly sidestepping the foundry bottleneck, this firm stepped up production in record time to get badly-needed recapping equipment to overtaxed military and civilian tire repair shops.

Five G-R welders (two Model 49, three Model 35) helped the welding department meet stepped-up schedules on time. A.C. welding, with no magnetic blow, with higher welding heat without undercutting, is the ideal answer to the demand for speed. And, for A.C. welding at its *best*, you can't beat G-R. The easiest way to prove it is to try it, on your own job. See your nearby G-R distributor and arrange for a demonstration now!

● G-R standard models range from 100 to 2,500 amp. capacity, manual or automatic. Power factor correction available on all models.



Top photo shows G-R Model 49 handling 1/4" rod on a steam jacket seam weld; lower view shows one of 3 model 35's on parts fabrication work.

GLENN-ROBERTS COMPANY

3100 E. TENTH STREET • OAKLAND 1, CALIFORNIA

2107 ADAMS STREET • INDIANAPOLIS 1, INDIANA

OKLAHOMA CITY

Cole, James L. (C), Oklahoma City Machine Wks., 1633 W. Main St., Oklahoma City 4, Okla.
Enochs, Elmer P. (C), Gen. Del. Stk. Yds. Sta., Oklahoma City, Okla.
Lee, Marvin L. (B), National Cylinder Gas Co., Oklahoma City, Okla.
Rogers, Orman B. (C), Box 812, Drumright, Okla.

PHILADELPHIA

Carr, John J. (B), Frank J. Lunney, 17th & Cambria Sts., Philadelphia 32, Pa.
Kobler, Julian (C), Arcos Corp., 401 N. Broad St., Philadelphia 8, Pa.
Prescott, Geo. R. (A), United Welding & Construction Co., Inc., 2502 Edgemont St., Philadelphia, Pa.

PITTSBURGH

Lawson, Thos. R. (B), Murrysville, Pa.
Patterson, Jas. H. (B), The Linde Air Products Co., 311 Ross St., Pittsburgh, Pa.

PORTLAND, ME.

Adams, Alexander G. (C), 30 Winter St., Portland, Me.
Coughlin, John E. (C), 24 St. Laurence St., Portland, Me.
French, Chas. W. (C), 5 Bonneybank Rd., S. Portland, Me.
Hanlon, Samuel O. (C), 5 "O" St., S. Portland 7, Me.
Howe, Francis C. (C), 112 Massachusetts Ave., S. Portland, Me.
Littlefield, Willis S. (C), Box 611, Ogunquit, Me.
Mahar, Dane G. (C), 23 Maple St., S. Portland, Me.
Marco, Wesley G. (C), R. F. D. 1, Bridgton, Me.
Mason, Clarence B. (C), Johnson Rd., R. F. D. 4, Portland, Me.
Milkey, Ernest N. (C), 533 Cottage Rd., S. Portland, Me.
Oppedisano, S. J. (C), 95 B Munjoy St., Portland 3, Me.
Ricker, Henry A. (C), 100 Anthoine St., S. Portland, Me.
Sangillo, Peter H. (C), 50 W. Pleasant St., Westbrook, Me.
Strout, Glenwood W. (C), 74 Church St., S. Portland, Me.
Williams, P. T. (C), 19 Elsmere Ave., S. Portland 7, Me.

PORTLAND, ORE.

Boylan, Earl (B), 644 E. 42d Ave., McLaughlin Hts., Vancouver, Wash.
Buck, Paul L. (B), 2347 N. Schofield St., Portland 3, Ore.
Simmons, W. A. (B), 4502 N. E. 42d Ave., Portland 13, Ore.
Smith, Bob (B), P. O. Box 461, Vancouver, Wash.
Wunn, Donald C. (B), Yard Training Bldg., Kaiser Co., Inc., Vancouver, Wash.

PUGET SOUND

Trexel, C. A. (C) 622 Exchange Bldg., Seattle 14, Wash.

ST. LOUIS

Fassel, Le Roi A. (C), 2818 Hilldale Dr., Brentwood 17, Mo.
Taylor, Earl E. (B), R. F. D. 1, Box 284, Granite City, Ill.

SAN FRANCISCO

Ashley, Geo. Wm., U.S.N. (C), c/o F.P.O. San Francisco, Calif.
Bush, D. T. (B), Permanente Metals Corp., Richmond, Calif.
Hale, Lt. Robt. S., (C), Rm. 2102, Administration Bldg., U. S Naval Drydocks, Hunters Pt., San Francisco 24, Calif.
Wakeman, Harry E. (B), Route 1, Box 529F, Los Altos, Calif.

SOUTH TEXAS

Myrow, Chas. F. (C), Stoody Co., Box 429, Whittier, Calif.

SYRACUSE

Mahoney, James D. (C), 108 Berwyn Ave., Syracuse 5, N. Y.

WESTERN MASS.

Krupke, Herman W. (C), 40 Mason St., Springfield 9, Mass.

WESTERN MICH.

Hulbert, Vivian (B), Box 129, Pentwater, Mich.
Slaughter, W. H. (B), Slaughter Mfg. Co., 3753 S. Division Ave., Grand Rapids, Mich.

WESTERN NEW YORK

Darr, Eugene E. (C), 476 Ashland Ave., Buffalo 13, N. Y.
MacKenzie, Walter C. (C), Beals McCarthy & Rogers, Inc., 50 Terrace, Buffalo 5, N. Y.

YOUNGSTOWN

Brown, Arthur H. (C), c/o Lukens Steel Co., Coatesville, Pa.
Gaupp, James L. (B), R. D. 2, Columbiana, Ohio.
Hippler, Franklin Z. (C), 519 E. Liberty St., Hubbard, Ohio.
Watson, Chas G. (A), The Youngstown Welding & Engr. Co., 3700 Oakwood Ave., Youngstown, Ohio.

YORK-CENTRAL PENNA.

Fish, George (C), York Corp., York Haven, Pa.
Kemper, Luther H., (C), 109 Fairview Ave., Waynesboro, Pa.
McCulloh, Wm. L., (D), Mercersburg, Pa.
Naughton, John F. (C), 1121 Olive St., Coatesville, Pa.
Parker, Harry A. (C), 124 E. Main St., Coatesville, Pa.
Turner, Joseph W. (B), H. P. Turner Co., Atglen, Pa.

NOT IN SECTIONS

Adams, John (C), Hays Mfg. Co., 801 W. 12 St., Erie, Pa.
Coates, William Stanley (B), Ashley Kate St., Morningside El., Brisbane, Queensland, Australia.
Herscovitch, Wm. (B), 120 Caroline St., South Jorra, Victoria, Australia.
Wilson, Harry (B), Holt Engr. & Pty., Ltd., Forest Rd. & Princes St., Bexley, Sydney, Australia.

Members Reclassified

During Month of February

CANADA

Morris, Ernest J. (from C to B), Reserve, Sask., Canada.

CHATTANOOGA

Stage, Pvt. K. F. (from D to C), A.P.O. 219, c/o P.M. New York, N. Y.

COLUMBUS

Romas, Marion V. (from D to C), 39 S. Hartford Ave., Columbus 8, Ohio.

INDIANA

Leonard, James A. (from D to C), 1823 Roosevelt Ave., Indianapolis 1, Ind.

LOS ANGELES

Passerello, Bert (from D to C), 1503 W. Spring St., Long Beach 6, Calif.

NEW JERSEY

Mackenzie, Robert (from C to B), 860 Livingston Rd., Elizabeth, N. J.
Vigani, Frank (from D to C), 126 Clarke Ave., Jersey City, N. J.

NEW YORK

Taylor, Robert (from D to C), 103 W. 120th St., New York 27, N. Y.

SAN FRANCISCO

Robbins, Lawrence (from D to C), 3028 Irwin St., Vallejo, Calif.

YORK-CENTRAL PENNA.

Haverstick, Harvey (from D to C), Rohrerstown, Pa.

NOT IN SECTION

Hopkins, P. A. (from D to C), c/o Hopkins Equip. Co., Hatfield, Pa.

Sections—CHAIRMEN, SECRETARIES, AND REGULAR MEETING DATES

ATLANTA — 1st Fri.
SECRETARY—J. V. TURNER, Air Reduction Sales Co., 336 Spring St., N. W., Atlanta, Ga.

BIRMINGHAM — 1st Thurs.
CHAIRMAN—W. B. BROWNING, The Linde Air Products Co., 1001-13 So. 22nd St., Birmingham, Ala.
SECRETARY-TREASURER—W. L. POOLE, Air Reduction Sales Co., 2825 N. 29th Ave., Birmingham, Ala.

BOSTON — 2nd Mon.
CHAIRMAN—F. W. DAVIS, E. B. Badger & Sons Co., 75 Pitts St., Boston, Mass.
SECRETARY—P. N. RUGO, 22 Eastern Ave., Wakefield, Mass.

BRIDGEPORT
CHAIRMAN—N. B. GILLILAND, 4883 North Main St., Stratford, Conn.
SECRETARY—C. PARKS, The Bullard Co., 286 Canfield Ave., Bridgeport 2, Conn.

BRUNSWICK, GA.
CHAIRMAN—W. A. PIERCE, JR., J. A. Jones Const. Co., Brunswick, Ga.
SECRETARY—W. P. BOLEN, 1303 Dartmouth St., Brunswick, Ga.

CHATTANOOGA, TENN. — 1st Wed.
CHAIRMAN—JUSTIN BROWN, Chattanooga Boiler Tank Co., 1011 E. Main St., Chattanooga, Tenn.
SECRETARY-TREAS.—R. G. WILSON, 1329 Chestnut St., Chattanooga 2, Tenn.

CHICAGO — 3rd Fri.
CHAIRMAN—C. L. PFEIFFER, 316½ N. Menard Ave., Chicago, Ill.
SECRETARY—T. B. JEFFERSON, *The Welding Engineer*, 506 S. Wabash Ave., Chicago, Ill.

CINCINNATI, OHIO
CHAIRMAN—GEORGE A. JACOBY, 1743 S. Derexa Dr., Hamilton, Ohio
SECRETARY—L. E. SHERMAN, Box 183, Lockland P. O., Cincinnati, 15, Ohio

CLEVELAND — 2nd Wed.
CHAIRMAN—ROSS J. YARROW, Republic Structural Iron Works, 1290 E. 53rd St., Cleveland, Ohio
SECRETARY-TREAS.—A. LESLIE PFEIL, Universal Power Corp., Cleveland, Ohio

COLUMBUS, OHIO — 2nd Fri.
CHAIRMAN—L. P. WOOD, Curtiss-Wright Corp., 4300 E. 5th Ave., Columbus 16, Ohio
SECRETARY—G. S. HERREN, The Seagrave Corp., Columbus, Ohio

DETROIT — 1st Fri.
CHAIRMAN—HENRY C. NEITZEL, Whitehead & Kales Co., 58 Haltiner, Detroit 18, Mich
SECRETARY—G. N. SIEGER, S-M-S Corp., 1165 Harper Ave., Detroit, Mich.

HARTFORD
CHAIRMAN—JOHN W. MORTIMER, The Whitelock Mfg. Co., P. O. Drawer 390, Hartford, Conn.
SECRETARY—R. H. FLORIAN, Trumbull Electric Mfg. Co., Plainville, Conn.

HAWAII — Last Thurs.
CHAIRMAN—GEORGE GLOVER, W. A. Ramsay, Ltd., Honolulu, T. H.
SECRETARY—ALAN G. SLIPPER, Hawaiian Gas Products Co., P. O. Box 2454, Honolulu, T. H.

INDIANA — 3rd Fri.
CHAIRMAN—J. R. WIRT, Process Dept. Delco-Remy Div., Gen. Motors Corp., Anderson, Ind.
SECRETARY—MRS. MERCEDES SPOTTS, P. R. Mallory Co., Indianapolis, Ind.

KANSAS CITY, MO. — 1st Tues.
CHAIRMAN—DUANE DE BRUNNER, Columbian Steel Tank Cor., 1509 W. 12th St., Kansas City, Mo.
SECRETARY—A. C. SLUSS, Moore Company, 556 Westport Road, Kansas City, Mo.

LEHIGH VALLEY
CHAIRMAN—J. W. KENWORTHY, 113 N. 11th St., Allentown, Pa.
SECRETARY—JULIUS NAAB, Ingersoll-Rand Co., Phillipsburg, N. J.

LOS ANGELES — 3rd Thurs.
CHAIRMAN—CHARLES A. BABBITT, Western Pipe & Steel Co., 5717 Santa Fe Ave., Los Angeles, Calif.
SECRETARY—E. O. WILLIAMS, Victor Equipment Co., Los Angeles, Calif.

LOUISVILLE — Last Tues.
CHAIRMAN—THEODORE H. LEWIS, Jeffersonville Boat & Machinery Co., Louisville, Ky.
SECRETARY—R. L. HOCHSTRASSER, Joseph W Greathouse Co., 530 River Road, Louisville 2, Ky.

MARYLAND — 3rd Fri., except April
CHAIRMAN—J. C. CUMBERLAND, Lexington Bldg., Room 1000, Baltimore, Md.
SECRETARY-TREAS.—W. H. SHAPROW, 3806 Ednor Road, Baltimore, Md.

MICHIANA
CHAIRMAN—W. G. FASSNACHT, Bendix Products Div., Bendix Aviation Corp. South Bend 20, Ind.
SECRETARY—G. O. HILL, Carnegie Illinois Steel, 1441 Chester St., South Bend 15, Ind.

MILWAUKEE — Last Fri.
CHAIRMAN—CARL MALMBERG, 555 Elm Spring Ave., Wauwatosa, Wis.
SECRETARY—CHAUNCY HART, Heil Co., 300 W. Montana St., Milwaukee

MOBILE
CHAIRMAN—REYNOLD ALONZO, Rt. 3, Box 24, Stanton Rd., Mobile, Ala.
SECRETARY-TREAS.—W. E. KELLY, 1561 Luling St., Mobile, Ala.

NEW JERSEY — 3rd Tues.
CHAIRMAN—G. N. NIGH, Tidewater Associated Oil Co., Bayonne, N. J.
SECRETARY—P. N. MATTERN, Wilson Welder & Metals Co., 60 E. 42nd St., New York 17, N. Y.

NEW YORK — 2nd Tues.
CHAIRMAN—G. V. SLOTTMAN, Air Reduction Sales Co., 60 E. 42nd St., New York 17, N. Y.
SECRETARY—GEORGE SYKES, The Linde Air Products Co., General Publicity Dept., 30 E. 42nd St., New York, N. Y.

NORTHERN NEW YORK — Last Thurs.
CHAIRMAN—H. S. SWAN, American Locomotive Co., Nott St., 5 Story Bldg., Schenectady, N. Y.
SECRETARY—R. S. PELTON, General Electric Co., Schenectady, N. Y.

NORTHWEST — 3rd Wed.
CHAIRMAN—C. M. UNDERWOOD, Northern Pump Co., Minneapolis, Minn
SECRETARY—ALEXIS CASWELL, Manufacturers' Assoc. of Minn., 200 Builders Exchange Bldg., Minneapolis, Minn.

OKLAHOMA CITY — First Thurs.
CHAIRMAN—H. N. SIMMS, 1217 S. W. 32, Oklahoma City, Okla.
SECRETARY—J. M. MIDEKE, 100 E. Main St., Oklahoma City 2, Okla.

PASCAGOULA
CHAIRMAN—W. B. BOWEN, The Ingalls Shipbuilding Corp., P. O. Box 149, Pascagoula, Miss.
SECRETARY-TREAS.—MILTON FORMAN, 1012 Cherubusco St., Pascagoula, Miss.

PEORIA—CENTRAL ILLINOIS — 3rd Wed.
CHAIRMAN—ALFRED A. WALD, Caterpillar Tractor Co., Peoria, Ill.
SECRETARY—FRANKLIN WATKINS R. G. Le Tourneau, Inc., Peoria, Ill.

PHILADELPHIA — 3rd Mon.
CHAIRMAN—G. R. JOHNSON, The Lincoln Electric Co., 401 N. Broad St., Philadelphia 8, Pa
SECRETARY—K. W. OSTROM, 213 Glen Gary Dr., Westgate Hills, Upper Darby P.O., Pa.

PITTSBURGH — Middle Wed.
CHAIRMAN—C. H. JENNINGS, Westinghouse Elec. & Mfg. Co., Pittsburgh, Pa.
SECRETARY—J. F. MINNOTTE, Minnotte Bros. Co., 1201 House Bldg., Hays (7) Pittsburgh, Pa.

PORTLAND, ME.
CHAIRMAN—A. R. SCHWERDTFEGER, 30 Richland St., So. Portland, Me.
SECRETARY-TREAS.—LEONARD W. COOPER, Falmouth Foreside, TownLanding, Portland, Me.

PORTLAND ORE.
CHAIRMAN—E. L. HANN, 940 S. E. 7th Ave., Portland, Ore.
SECRETARY—PAUL KULLBERG, Industrial Specialties Co., 940 S. E. 7th Ave., Portland 14 Ore

PUGET SOUND — Last Wed.
CHAIRMAN—G. L. TAPLEY, Webster Welding Co., 1211 Pine St., Seattle, Wash.
SECRETARY—J. BARR, Todd Pacific Shipyard, Seattle, Wash.

ROCHESTER, N. Y. — 1st Thurs.
CHAIRMAN—PAUL A. ECKLUND, 36 Hargrave St., Rochester, N. Y.
SECRETARY—EDWARD R. JONES, Allen Iron & Welding Wks., 133 Murray St., Rochester 6, N. Y.

SAN FRANCISCO — Last Fri.
CHAIRMAN—C. F. DOGGETT, Moore Dry Dock Co., Ft. Adeline St., Oakland, Calif.
SECRETARY—R. E. LABAGH, Victor Equipment Co., 844 Folsom St., San Francisco, Calif.

ST. LOUIS — 2nd Fri.
CHAIRMAN—W. S. EVANS, 789 Glen Vista, Glendale, Mo.
SECRETARY—H. C. CLOSS, Machinery & Welder Corp., 700 S. Spring Ave., St. Louis, Mo.

SOUTH TEXAS — 3rd Thurs.
CHAIRMAN—E. C. JACKSON, Southern Pacific Lines, 324 Southern Pacific Bldg., Houston, Texas
SECRETARY-TREAS.—A. E. WISLER, Hughes Tool Company, 300 Hughes St., Houston, Texas

SYRACUSE — 2nd Thurs.
CHAIRMAN—ROBERT GREER, Carrier Corp. 302 S. Geddes St., Syracuse, N. Y.
SECRETARY—J. HOTCHKISS, 1590 Westmoreland Ave., Syracuse 10, N. Y.

TIDEWATER
CHAIRMAN—C. O. BARHAM, 1501 Lansing Ave., Portsmouth, Va.
SECRETARY-TREAS.—E. C. ROWELL, 118 Oregon Ave., Portsmouth, Va.

TOLEDO — 3rd Tues.
CHAIRMAN—EDWIN NAPZGER, Toledo Steel Tube Co., 2105 Smead Ave., Toledo 6, Ohio
SECRETARY—LLOYD BERSTICKER, 4234 Templer Road, Toledo 12, Ohio

WASHINGTON, D. C. — 2nd Tues.
CHAIRMAN—C. E. JACKSON, Naval Research Lab., Washington 20, D. C.
SECRETARY—G. G. LUTHER, Naval Research Lab., Anacostia Station, Washington, D. C.

WESTERN MASSACHUSETTS — Last Mon.
CHAIRMAN—EMIL STOLTE, Westinghouse Elect. & Mfg. Co., 653 Page Blvd., Springfield 2, Mass
SECRETARY—E. J. PELTIER, Westinghouse Elect. & Mfg. Co., 653 Page Blvd., Springfield 2, Mass.

WESTERN MICHIGAN
CHAIRMAN—W. J. ELBROOKE, Haven-Busch Co., 501 Front N. W. Grand Rapids, Mich,
SECRETARY—R. D. LAYMAN, The Lincoln Electric Co., 200 Division Ave., Grand Rapids 2, Mich.

WESTERN NEW YORK — 3rd Fri.
CHAIRMAN—JOSEPH COUSINS J. D. Cousins & Sons Boiler Wks., 667 Tifft St. Buffalo, New York
SECRETARY—R. S. LANE, Ross Heater & Mfg. Co., 1407 West Ave., Buffalo, N. Y.

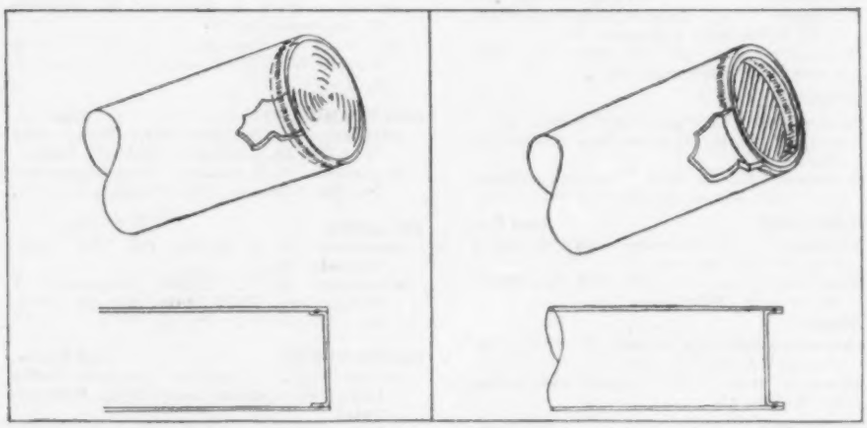
WICHITA, KAN. — 3rd Wed.
CHAIRMAN—R. W. TOWNSEND, 266 South Minneapolis, Wichita, Kan.
SECRETARY—M. L. LAMPTON, 2312 N. Minnesota, Wichita, Kans.

YORK—CENTRAL PA. — 2nd Wed.
CHAIRMAN—C. E. LEWIS KERCHNER, R. D. No. 1, Thomasville, Pa.
SECRETARY—PAUL DRESSEL, Dressel Spring Works, 325 Prospect St., York, Pa.

YOUNGSTOWN, OHIO — 3rd Thurs.
CHAIRMAN—ARTHUR W. WALDO, Youngstown Welding & Eng. Co., 3700 Oakland Ave., Youngstown, Ohio
SECRETARY—H. ROSS STROHECKER, Youngstown Welding & Eng. Co., Youngstown, Ohio

DESIGN FOR RESISTANCE WELDING

No. 2 of a Series of Bulletins on Preferred Designs for Resistance Welding Assemblies



POOR

Seam welding heads to deep shells with flange inside requires deep throat machine with high capacity. Work set-up and handling is difficult.

GOOD

With flange turned outside, machine of minimum throat depth and capacity can be used. Operation is easier and faster.

Simplifying the operation lowers the cost of seam welding

THE preferred design shown above results in cost savings which are impressive, especially in the case of deep shells with small diameter heads. For example, assume a tank 30″ long by 8″ in diameter, made of 16-gauge SAE 1010 steel. The first design would require a machine with a deep throat and a high transformer capacity. For welding the preferred design, a machine of about half the transformer capacity and with minimum throat depth can be used, with a 15 per cent saving in the welding machine cost.

With the recommended procedure, up to 25 per cent better production is possible, and the demand charge will be lower. It is possible to use a double knurl drive with the preferred design, which results in longer wheel life, less maintenance cost and less down-time. Also, this design permits seam welding heads in both ends.

This case is typical of production improvements and economies which can be accomplished by designing parts to simplify the welding operation. Advice on parts design to improve your product and reduce your costs can be obtained from members of the Resistance Welder Manufacturers' Association. Write to them concerning your resistance welding applications and problems.

RESISTANCE WELDER MANUFACTURERS' ASSOCIATION

505 Arch Street • Philadelphia 6, Pa.

$500 to be awarded

for the best technical paper on

DESIGN FOR RESISTANCE WELDING

A cash prize of $500 will be awarded for the best paper emanating from an industrial source, consulting engineer, government laboratory, or the like, in which a major portion of the subject matter is concerned with design for resistance welding. This includes design of component parts to accomplish maximum economy and welding quality, and also details of procedure, work preparation, work handling, etc.

Other cash prizes are offered for papers on resistance welding applications and research. Write to Resistance Welder Manufacturers' Association for complete information.

RESISTANCE WELDER MANUFACTURERS ASSOCIATION · RWMA

MEMBERS OF RWMA

Acme Electric Welder Company
Los Angeles 11, California

Eisler Engineering Company
Newark, New Jersey

Expert Welding Machine Company
Detroit, Michigan

The Federal Machine & Welder Company
Warren, Ohio

Multi-Hydromatic Welding & Mfg Co.
Detroit, Michigan

National Electric Welding Machines Co.
Bay City, Michigan

Progressive Welder Company
Detroit 12, Michigan

Sciaky Brothers
Chicago 38, Illinois

Swift Electric Welder Company
Detroit 10, Michigan

Taylor-Hall Welding Corporation
Worcester 3, Massachusetts

The Taylor-Winfield Corporation
Warren, Ohio

Thomson-Gibb Electric Welding Co.
Lynn, Massachusetts

Welding Machines Manufacturing Co.
Detroit, Michigan

THE ALLOY GROUP

Electroloy Company, Incorporated
Bridgeport, Connecticut

P. R. Mallory & Company, Incorporated
Indianapolis, Indiana

S-M-S Corporation
Detroit 11, Michigan

Welding Sales & Engineering Company
Detroit, Michigan